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ABSTRACT

This unit introduces students to the diversity of rice culture and rice-based farming systems in Asia and the Pacific. Students examine issues related to the needs of the future global population. Six rice-producing countries are under study: Bangladesh, China, Indonesia, Japan, Philippines, and Thailand. The lessons include: (1) "Rice in Asia and the Pacific"; (2) "The Historical and Cultural Importance of Rice"; (3) "Population Growth and Rice"; (4) "Technology and Rice"; (5) "Biodiversity in Rice Production"; (6) "Rice Policy and the Stages of Agricultural Development"; and (7) "International Rice Summit." The document concludes with a letter to the students, a glossary of terms, and an extensive reference list. (EH)

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ED 399 204

FEEDING A HUNGRY WORLD: FOCUS ON RICE IN ASIA AND THE PACIFIC

Developed by Gary Mukai
Heidi Ballard and Ann Ishimaru

with contributions from
Dr. Michael Midling, Adam Rubin, Kerry Sherman, Megumi Shibamiya,
and Victor Tubbesing

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Unit Introduction

FEEDING A HUNGRY WORLD:
FOCUS ON RICE IN ASIA AND THE PACIFIC

Rationale and Introduction to Lessons

> Rice, that crucial grain, is an integral part of human history, tied to us in countless traditions, interwoven into the oldest religious rites. We rightly say rice "culture" since this life-giving grain is part of human cultural evolution. Rice is the world's only crop planted by emperors and kings, offered to the Gods, and eaten by both the wealthiest and the poorest. Rice is more than simply a food composed of carbohydrate, protein, fat, and micronutrients. It has been a companion of humankind for more than 7000 years, back beyond our knowledge, beyond our imagination (IRRI 1993-94, *Filling the World's Rice Bowl*, p. 5.)

By the year 2050, there will be about 10 billion people in the world, about half of them in Asia. Most of these 5 billion people will be rice consumers. By current estimates, the world's rice production must rise by 70 percent over present levels. To make this happen, 870 million tons of unmilled rice will be needed each year, and the rice must be grown with less water, less labor, fewer losses, less pollution, and on much less land than today. At the present, the daily existence of more than two billion people depends on rice, and the world is not prepared for the challenge of feeding a hungry world in the next half century.

Each year, global population swells by more than 80 million people, and each year, millions of hectares (1 hectare = approximately 2.47 acres) of prime cropland are shifted out of agricultural production for purposes of industrialization and urbanization. Populations in the major rice-consuming countries continue to grow, while growth in rice production has slowed dramatically in the ten countries that account for 85 percent of the global production of rice.

The purposes of *Feeding a Hungry World: Focus on Rice in Asia and the Pacific* are to introduce students to the diversity of rice culture and rice-based farming systems in Asia and the Pacific and to help provide students with skills to prepare for the needs of the future global population. Students will focus on six rice-producing countries: Bangladesh, China, Indonesia, Japan, Philippines, and Thailand.

Lesson 1 introduces rice production in Asia and the Pacific as a case study of global issues. Students in six small groups, which very roughly represent the six countries listed above, engage in a

simulation involving negotiation, decision making, and rice planting; and are introduced to the issues of population growth, environmental degradation, unequal resource distribution, and food production.

Lesson 2 focuses on the importance of rice in Asia and the Pacific. Students study the historical role of rice as a staple food and engage in one of six activities designed to illustrate the cultural importance of rice in the six countries. The activities are interdisciplinary and interactive, and engage students through literature, folktales, puppetry, storytelling, Chinese characters, poetry, and personal narrative.

Lesson 3 examines the impact of population growth on rice production now and in the future. This lesson is divided into two parts that enable students to explore the concepts and connections between population growth and resource use in rice production in the six countries. Part 1 looks at the rate and meaning of population growth over time through an exercise using popcorn and egg cartons. Part 2 examines the notion that we are living in a world of limited resources and presents us with questions about the implications for the future.

Lesson 4 explores the balance between increasing the production of rice with the recognition that certain technologies can, in the long term, undermine our ability to sustain rice production, endangering the basic resources—such as water and land—and biodiversity that make it possible to cultivate rice. By studying a rice farm in Indonesia, students will explore different methods and technologies as well as their environmental and social trade-offs.

Lesson 5 introduces students to issues surrounding biodiversity. Through this lesson, students will begin to explore the vital connections between different life forms and human decision making and thus discover the critical importance of biodiversity in sustaining life on the earth. The activities in this lesson explore the role and importance of biodiversity in rice cultivation in Asia and the Pacific. A brief introductory activity introduces the concept and types of biodiversity through familiar examples. The body of the lesson consists of three parts that examine the genetic, species, and ecosystem diversity of rice.

Lesson 6 presents an overview of three stages of agricultural development and the importance of agricultural policies. Each of six small groups of students will receive a data packet containing pertinent tables and charts, as well as a short summary of rice issues facing one of the six countries. Students will analyze the data in preparation for an International Rice Summit, organized for lesson 7.

In lesson 7, the year is now 2050. Students assemble in their original groups of six countries and assess the outcomes of their

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decisions at the beginning of the unit. Students examine their rice plants that have been growing throughout the course of the unit, and discuss issues and concerns. Because of a massive rice crop failure in China, the six countries then meet at an International Rice Summit. Students utilize policy information from lesson 6 as well as other information from previous lessons in this simulation.

Unit Goals

Each of the seven lessons in this curriculum unit has specific learning objectives listed. These objectives have been divided into knowledge, attitude, and skill objectives for students. The following list reflects goals for the curriculum unit as a whole.

In this curriculum unit, students will:

- learn about the geography of Asia and the Pacific
- learn about the historical and cultural importance of rice in Asia and the Pacific
- interpret statistics
- develop a sense of personal, national, and international responsibility for the environment
- understand the impact of population growth on rice production
- learn to evaluate the use of technology critically
- become familiar with issues surrounding biodiversity
- learn to think critically and make informed opinions
- evaluate policy issues
- learn skills to enhance awareness and communication
- work effectively in small and large groups
- organize and express opinions in a debate

Materials

Handouts and primary source documents have been provided with each lesson to present students with a range of perspectives on the topic being studied. Permission is given to reproduce these handouts and documents for classroom use only. A list of materials for each lesson is provided in each lesson.

Time, Suggested Sequence of Activities

Feeding a Hungry World: Focus on Rice in Asia and the Pacific is divided into seven lessons. We recommend 2-3 class periods for each lesson. The various activities have been designed to give students multiple perspectives on the topic being studied.

unit introduction

Small Group Roles

Feeding a Hungry World: Focus on Rice in Asia and the Pacific engages students in many small group activities. The suggested roles and responsibilities for students working in small groups are listed in the individual lessons.

Grade Levels

Grades 7-12

Subjects

This curriculum unit is recommended for use in social studies, environmental studies, science, Asian studies, and contemporary issues classes.

Equipment

Overhead projector

Icons

For easier reference the following icons are used throughout the unit:

Notes to the Teacher

Student Cards

Homework

Small Group Activity

Transparency

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Lesson 1

RICE IN ASIA AND THE PACIFIC:
A SIMULATION

Organizing Question

- What are some of the major issues affecting rice production in Asia and the Pacific?

Introduction

> Perhaps the most important aspect of the global perspective on the world food problem cannot readily be captured in price or trade statistics. The world's food economy is now intimately and probably inextricably interdependent.... Solutions are likely to be found not by attempts to dismantle this new interdependence but by a better understanding and utilization of its positive potential at the national level (Peter Timmer, Walter Falcon, and Scott Pearson, "Introduction to Food Policy Analysis," in *Food Policy Analysis*, pp. 4–5.)

This simulation will introduce students to the issues of population growth, environmental degradation, unequal resource distribution, and food production. Students will work in six small groups, which represent the six countries of Bangladesh, China, Indonesia, Japan, Philippines, and Thailand, to grow rice for their populations and to make decisions that involve weighing short-term and long-term consequences. Through first-hand experience, students will come to appreciate the interdependence of nations on an international level and the connections between different needs and resources within each country.

This introductory lesson is, in a sense, a framing experience to which students will return at the end of the unit. The first part of the simulation consists primarily of negotiation within and among nations and the planting of the rice seeds; the activity resumes in the final lesson of the unit when students participate in an International Rice Summit. The time delay in the simulation allows students to perceive and learn from the long-term consequences of their decisions, to discover additional information and skills pertaining to rice production in Asia and the Pacific during the course of the unit, and finally, to reapply what they have learned at a final International Rice Summit.

The six rice growing countries in the simulation have varying populations, needs, and resources that very roughly approximate the following nations:

- Bangladesh (Group B)
- China (Group C)

- Indonesia (Group I)
- Japan (Group J)
- Philippines (Group P)
- Thailand (Group T)

Through actual experience, students will begin to learn the skills they need to effectively prepare for the future in a changing, complex, and highly interdependent world.

Objectives

knowledge

- to distinguish between food shortage, food poverty, and food deprivation
- to learn about issues facing the rice-producing countries of Bangladesh, China, Indonesia, Japan, Philippines, and Thailand
- to learn some statistical information about these countries

attitude

- to perceive the complexity and connections between food production, environmental degradation, population growth, and international trade
- to consider the unequal distribution of resources in the world and within countries and its impact on people's lives
- to discuss how the experience in the simulation parallels rice production in the real world and how rice production is a specific case of these interacting issues on a global scale
- to describe one's own perspectives and recognize and respect the different perspectives of other individuals and groups

skill

- to experience the need for cooperation and effective communication when trying to prepare for the future
- to begin making decisions that balance short-term needs with long-term needs

Materials

- soil
- water
- rice seeds
- 20 plastic gallon containers (available at nurseries)
- Using Simulations, for the teacher
- Proportion and Number of Chronically Underfed, overhead transparency
- Handout #1: Individual Roles for Simulation, 6 copies
- Country Information Sheet B, one copy
- Country Information Sheet C, one copy
- Country Information Sheet I, one copy
- Country Information Sheet J, one copy

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- Country Information Sheet P, one copy
- Country Information Sheet T, one copy
- Care Schedule Cards, one copy
- Money Tokens, two copies cut apart
- Diplomat Tags, one copy
- World Map, overhead transparency
- Main Geographical and Political Regions of Asia, overhead transparency
- Political Map of Asia, overhead transparency
- Map of Rice-Growing Regions of Asia, overhead transparency
- Overhead projector

Prior to teaching this lesson, refer to "Using Simulations" on page 16. In addition, assemble the following for six groups of students:

Group B

- 1 plastic gallon container
- soil
- Care Schedule Card #5
- 5 seeds
- 1 money token
- Diplomat B nametag
- Country Information Sheet B

Group C

- 8 plastic gallon containers
- soil
- Care Schedule Card #6
- 15 seeds
- 2 money tokens
- Diplomat C nametag
- Country Information Sheet C

Group I

- 4 plastic gallon containers
- soil
- Care Schedule Card #1
- 20 seeds
- 2 money tokens
- Diplomat I nametag
- Country Information Sheet I

Group J

- 2 plastic gallon containers
- soil
- Care Schedule Card #2
- 60 seeds

- 20 money tokens
- Diplomat J nametag
- Country Information Sheet J

Group P

- 2 plastic gallon containers
- soil
- Care Schedule Card #3
- 30 seeds
- 2 money tokens
- Diplomat P nametag
- Country Information Sheet P

Group T

- 3 plastic gallon containers
- soil
- Care Schedule Card #4
- 40 seeds
- 3 money tokens
- Diplomat T nametag
- Country Information Sheet T

Identify six areas in the classroom as follows (the groups will be growing their rice in these areas):

Group B: near window, but not in direct sunlight

Group C: sunny spot by a window

Group I: shaded area

Group J: sunny spot by a window

Group P: near window, but not in direct sunlight

Group T: sunny spot by a window

Identify six areas in the classroom where each "country" can sit in close-knit groups to discuss their decisions.

Identify a central area in the classroom for the diplomats to convene and negotiate.

Procedure

1. Explain to students that the purposes of *Feeding a Hungry World: Focus on Rice in Asia and the Pacific* are to introduce students to the diversity of rice culture and rice-based farming systems in Asia and the Pacific, and to help provide students with skills to prepare for the needs of the future global population.
2. Begin with a preliminary discussion of food and hunger. An important question for students to discuss is: What do we mean by hunger?

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This is an important question for students to consider throughout this curriculum unit. For the purposes of this opening discussion, point out the following distinctions:

- Food shortage: occurs when total food supplies within a designated area—globally, regionally, or within countries—are insufficient to meet the needs of the population living in that area. This is a *physical* concept.
- Food poverty: occurs when households or individuals do not have the income or resources to obtain the food they need. This is an *economic* concept.
- Food deprivation: occurs when individuals have inadequate consumption of food, or, especially, of specific nutrients. This is a *nutritional* concept.

3. Using the overhead transparency, Proportion and Number of Chronically Underfed, have students describe trends for each of the regions listed. Students should note the following from the transparency:
   - In Sub-Saharan Africa, the proportion in percentages of the chronically underfed has remained quite constant.
   - In the Near East, North Africa, East Asia, and China, the proportion in percentages of the chronically underfed has dropped dramatically.
   - In Middle America, South America, and South Asia, the proportion in percentages of the chronically underfed has dropped but not quite as dramatically.
   - In Sub-Saharan Africa, the absolute numbers of chronically underfed has risen dramatically.
   - In Middle America, South America, and South Asia, the absolute numbers of chronically underfed has remained fairly constant.
   - In the Near East, North Africa, East Asia, and China, the absolute numbers of chronically underfed has dropped, in some cases dramatically.
   - Students should also note that though the proportion in percentages of the chronically underfed may remain constant, for example, in Sub-Saharan Africa, the absolute numbers of the chronically underfed may rise dramatically.

Explaining the Simulation

1. Explain that the students will be participating in a simulation. This simulation will introduce students to the issues of population growth, environmental degradation, unequal resource distribution, and food production. Students will work in six small groups to grow rice for their populations and to make decisions that involve weighing short- and long-term consequences. Through firsthand experience, students will come to appreciate the interdependence of nations on an international level and the connections between different needs and resources within each country.

During the simulation, students will form "countries" of approximately 5 individuals and meet to select roles. Explain the different roles within each country. These are explained in Handout #1, Individual Roles for Simulation. You may want to distribute one copy of Handout #1 to each group. Each country should have:

- 1 diplomat
- 1 government official
- 1 farmer
- 1 environmental scientist
- 1 citizen

2. Ask students to assemble into their six countries, choose roles, and explain that the objective of the activity is to grow enough rice to feed the people in each country. Because it will take time to grow the rice, the activity will be completed at the end of the unit. For the sake of the simulation, the end of the unit will be the year 2050.

3. Explain that each group will receive a set of materials and instructions but will need to trade with other groups to get the materials and information necessary for planting their rice.

4. Explain the following rules for trading:

   - Groups can communicate with each other only through their diplomats.
   - Diplomats meet in the central negotiating area for one-minute periods. They may not return to their groups until the negotiation period is over.

5. When a group decides it is finished negotiating and ready to plant its rice seeds, it must indicate this decision to the teacher. Negotiation periods end when all groups decide that they have the materials they need to sow their rice crop or after five negotiation periods. Or you may prefer to set a time limit for the activity after which groups must plant with whatever materials they have available.

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Playing the Simulation

1. Distribute the materials to Groups B, C, I, J, P, and T. Announce that the members of each country have 5–10 minutes to read the information, plan the group's strategy, and decide what the diplomat will do in the first round of negotiations.
2. Before beginning the negotiations, ask for final questions about the activity. If students require technical or other information, explain that they must negotiate with other countries for this information. Once the activity starts, students will no longer be able to consult the teacher or simulation facilitator.
3. Begin the simulation. Announce the first negotiating period. Carefully time the one-minute negotiating periods and allow three to five minutes between each negotiating period for group planning. Unless students' safety is in jeopardy, do not intervene if conflicts arise so that the groups may work out the problem themselves.
4. Stop the activity when all nations indicate that they have the materials needed to plant their rice or after five negotiation periods. Not all countries may be satisfied with the results of their negotiating, but after about five negotiation periods, all countries need to decide that they are finished negotiating and are ready to plant their seeds.
5. Each group plants its seeds and waters them for the first time before placing them in the designated growing areas.
6. Ask each group to devise a way to make sure the plants are cared for according to the care schedule cards.
7. IMPORTANT: Allow at least thirty minutes at the end of the simulation to debrief individual and group feelings and reactions.

Debriefing

This simulation constitutes a complex set of interactions that tie together many different aspects of food production, population, environmental sustainability, international trade, and resource distribution. As it would be impossible to cover all aspects of these linkages, the following list constitutes only some of the more important aspects. According to the experience and interests of the students, the debriefing and discussion may pursue any of these interrelated topics.

1. How do you feel about your participation in the activity? Ask students in different roles how it felt to play that role, how others reacted to her/him. What was the most challenging or frustrating part of the activity? the most rewarding?
2. What kinds of things made you feel these ways? Discuss feelings of frustration, excitement, power, anger, etc. Were there particular interactions that elicited strong reactions?

3. Bring out the inequity of resource distribution. How did students feel when they realized that their materials were unequal? Which group(s) had more power in the negotiations? Which group had the least power? Was there a relationship between that power and the resources of the various groups?
4. Make a list on the board of the different groups and the opinions or perceptions held about each group by the others. Ask each group if they agree with the perceptions of the other groups. Why might one group seem to be a certain way (e.g., greedy, generous, or selfish)? Discuss how these perceptions might relate to the resources each group had to work with.
5. What were some of the conflicts during the activity? What were some of the negotiations that worked the best? How did people communicate in these different kinds of interactions? Discuss the importance of effective communication in individual and group interactions.
6. Reflecting back on the simulation, what would you do differently if you had a chance to do it again? What would make things go more smoothly? How might you avoid certain conflicts?
7. What do you predict will happen when it comes time to "harvest" your crops? What if not all the seeds sprout? How did you decide that you were ready to plant?

Analogies in the World

Continue the debriefing by having the students draw analogies between the simulation and the real world using the following questions:

1. What aspects of the simulation resemble the situation of nations in the world today? How are they different? Record answers on a piece of butcher paper for use at the end of the unit. Be sure to consider the following: role of money (only meaningful if two or more parties agree that it has value); influence of values and resource distribution on perception and communication; international interdependence; decision making; power dynamics, both intra-group and inter-group; connections between population, environment, food production, and international relations.
2. Competition may have arisen in the activities. If so, what purpose did it serve? Could each group meet its needs alone? Discuss the notion of interdependence. What are the benefits of cooperation? competition? Ask students to come up with specific examples of interdependence in the simulation and in the world.
3. As groups, you had to make many decisions and weigh different alternatives. What kinds of questions did you ask

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when trying to make those decisions? Did it make a difference that you knew you would have to wait for the rice to grow? When did you have to weigh present needs with needs for the future? Discuss how most decisions about food production and the environment involve balancing short-and long-term consequences. What are some examples of decisions in which you had to weigh short- and long-term outcomes (e.g., doing homework, or hanging out with friends)?

4. Look at the dynamics within groups and point out that even within a country, not everyone agrees; some people still benefit more than others. How were decisions made and who made them? What does this mean about who has power within countries? Why do you think some people have more power than others?

5. Ask students: Where does rice grow in the world? Why does it grow in these areas?

   Note that the farmers of Asia grow 92 percent of the world's harvested rice. In the humid and subhumid tropics, rice is the primary source of human energy. In Bangladesh, Cambodia, Laos, Myanmar, Thailand, and Vietnam, rice provides 55 to 80 percent of the calories consumed. In most of Africa and Latin America, rice is less important. On average, rice contributes 10 percent or less of total calorie intake. But in Guinea, Guyana, Liberia, Madagascar, and Sierra Leone, 29 to 50 percent of the calories eaten come from rice. (Source: International Rice Research Institute: "Rice Facts," 1995)

6. Tell students that the groups they represented in the simulation correspond loosely to real countries. Ask each group to discuss which country in the world they might have been. Put the Political Map of Asia transparency on the overhead and identify the six countries in the simulation, revealing to each group which country they role-played. Depending on the background of your students, you may also want to utilize the transparencies of the World Map and Main Geographical and Political Regions of Asia. Lastly, show the Map of Rice-Growing Regions of Asia transparency. Please note that distinguishing features between irrigated rice, rainfed lowland rice, upland rice, and flood-prone rice will be covered more extensively in lesson 5, Biodiversity in Rice Production.

7. Explain that rice grows best in humid subtropical environments with relatively high temperatures during the growing season and a monsoon season that brings abundant rain. Rice can also be grown in temperate zones with high summer temperatures such as California and Egypt. Most rice is grown in flooded fields, so soils must be impermeable clay soils with little alkali, sodium, or salinity. Explain any terms

that are unfamiliar to students (see Glossary at end of unit for definitions of terms).

Limitations of a Simulation and Ideas for Further Discussion

1. This simulation was based on a strict relationship between food production and population. This "supply side" perspective assumes that if enough rice were produced, everyone in a country would be able to eat. This is not necessarily the case, though. Explain that the "demand side" of hunger shows us that food consumption is often more a matter of economic power than availability. The amount of rice eaten by a population is determined largely by how much money people have and how much rice they can afford to buy. This means that the cost of rice is very important both from the perspective of how much a farmer gets for his/her rice and from the perspective of how much people can afford to buy for consumption.
2. The simulation assumed that all the countries were self-sufficient in their rice production; that is, they grew all the rice their populations needed, and people ate only rice grown in their own countries. What would Japan do if it became too expensive to produce rice itself? Due to labor costs, yield factors, weather, or other reasons, a country may decide that it makes more sense economically to buy its rice from another country than it does to produce it. In economics, the other factors that sometimes make it cheaper to buy rice than to grow it are called "opportunity costs."

   The assumption of self-sufficiency in this simulation, though, is not unrealistic. Many countries are striving for self-sufficiency in rice production because the price of rice in the international market sometimes leaves poorer countries unable to buy rice from other countries. Some countries don't even consume their own rice, but sell almost all of it to other countries (for example, the United States).
3. In actual rice production, there are many factors that influence the productivity of rice. What are some of these factors? Which of the variables manipulated in this simulation represent those in actual rice production (e.g., water and rain or irrigated water; the containers and the area of land available for production)? Explain that there are other longer term impacts on the soil and climate that we couldn't see in the simulation because they operate on a scale of years, not weeks. Introduce a few of these (prolonged herbicide and chemical input use, urban pollution in water, global climate change due to nitrogen fertilizer and rice paddies). Explain that these issues will be explored in later lessons during the unit.
4. Reiterate the complexity of these issues and the connections that exist between different countries and the ways they feed

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their people. Use the feelings evoked in the simulation to begin to understand the difficulty or ease with which different countries deal with these issues. Why do some countries have so much more than others? What kinds of questions do we need to ask to help overcome these barriers?

5. Discuss the fact that a simulation is an artificial simplification of a more complex reality. What other kinds of issues or interactions are left out? Introduce the ideas of culture, taste, other crops, and the international market, as factors in rice production, consumption, and trade.

6. Bring closure to this lesson by announcing that lesson 2 will introduce students to the historical and cultural importance of rice in six countries.

For homework, ask the students in each group to imagine they are visitors in their simulation country. In order to know what to pack, they will need to find out about the climate of the country.

- What is the average temperature in December? in August?
- What kind of weather can they expect if they visit in the winter? in the summer?
- How much rain does the country get every year?
- Do they have to worry about storms during any season?

Most or all of this information can be found in an encyclopedia, atlas, or other basic reference book.

7. In a follow-up class, make a brief list on the board of the climate and soil features of each country. Discuss the similarities in climate across the six countries.

USING SIMULATIONS[1]

A simulation is an important learning activity which involves students in roles where they must think and act in a situation that is similar to one in real life. William A. Nesbitt has described a simulation as a "working model of reality." In this lesson, students consider issues related to being able to provide enough rice for their "nations" in the year 2050. Although never able to duplicate the complexity of a real event or teach specific facts, a simulation may allow students to exercise some of the problem solving skills and experience some of the decision making that occur in a real event. A simulation should never be treated lightly as "only a game." Good simulations have the capacity to generate very strong thoughts and feelings in their participants, and the teacher always should be prepared for that possibility.

Although simulations involve role-play, they operate within the constraints of a pre-designed set of rules and roles. In this lessons, the various roles are:

- 1 (or more) diplomat(s)
- 1 government official
- 1 farmer
- 1 environmental scientist
- 1 citizen

While the general framework is defined, a certain degree of flexibility in the rules leaves room for students to bring their prior experience and personal values to the activity.

Careful thought should be given to the placement of a simulation in a unit of instruction. How does it help achieve the goals of the unit? Which concepts and skills will this experience help develop? Is there prior information needed that will enhance the students' participation in the simulation and/or help link the experience to real-life situations? Will the simulation set a context for material to be studied in the future? How can the simulation be structured to allow adequate time for orientation, play, debriefing, and follow-up? Is the complexity of the simulation appropriate for the age and experience of the students? Is the available physical space adequate?

The role of the teacher is absolutely critical. The teacher serves as an orientation leader and a facilitator. A simulation is run most successfully when participants have had a clear, concise introduction to its framework. As rules and roles are explained, time should be allowed for questions and practice. It is important, however, that the focus remain on the framework of the activity. The facilitator should avoid comments or answers that suggest strategies or imply outcomes.

During the simulation, the facilitator should carefully observe the proceedings and take notes that may help guide the debriefing. It is important to remember

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[1] Adapted from *Heelotia: A Cross-Cultural Simulation*, © 1991, SPICE

that the students will sometimes select strategies that don't work and communications may sometimes become tense and difficult. Unless the participants' safety is jeopardized, the facilitator should not coach or intervene in the interaction, allowing students the opportunity to solve problems directly.

Debriefing a simulation is essential. Unless there is adequate time for debriefing, a simulation should not be attempted. Inadequate debriefing may leave a residue of misunderstandings and/or misinformation, which may have negative consequences both in and outside of the classroom. Equally important is the lost opportunity for reflection and learning. Debriefing questions are provided for this simulation in the procedures of this lesson. Debriefing questions for simulations should include questions that elicit:

- a description of what happened
- how the participants felt during the simulation and how they are feeling afterward (both as members of groups in which they participated during the simulation and as individuals)
- strategies that were attempted and their results
- other strategies that might have been possible
- analogies to real-life situations and a discussion of how this simulation was the same or different
- how the situation related to the students' own values and their subsequent actions during the simulation
- questions that remain for future study and ways to pursue those questions

Traditional evaluation methods generally are not appropriate for simulations. Students should never be evaluated for their participation in the simulation itself. Many teachers have found an effective evaluation activity to be a journal entry or other writing exercises in which students summarize their insights from the activity and its debriefing.

Simulations are often noisy and sometimes confusing. They require considerable flexibility. Yet, they have a high potential for developing deepened understandings of key concepts and increased skill in decision making, communication, negotiation, and conflict management, making them an important learning tool.

transparency

PROPORTION AND NUMBER OF CHRONICALLY UNDERFED

Proportion in Percentages	Sub-Saharan Africa	Near East & North Africa	Middle America	South America	South Asia	East Asia	China	All
1970	35	23	24	17	34	35	46	36
1975	37	17	20	15	34	32	40	33
1980	36	10	15	12	30	22	22	26
1990	37	5	14	13	24	17	16	20
Absolute Numbers (in millions)								
1970	94	32	21	32	255	101	406	942
1975	112	26	21	32	289	101	395	976
1980	128	15	18	29	285	78	290	846
1990	175	12	20	38	277	74	189	786

Source: Administrative Committee on Coordination/Subcommittee on Nutrition. *Second Report on the World Nutrition Situation; Volume 1 Global and Regional Results.* Geneva: ACC/SCN, 1992.

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INDIVIDUAL ROLES FOR SIMULATION

Each individual should have a role within your country:

Diplomat: follows the decisions of the country as much as possible; carries out all negotiations with other countries; is the sole "international" communicator of the group.

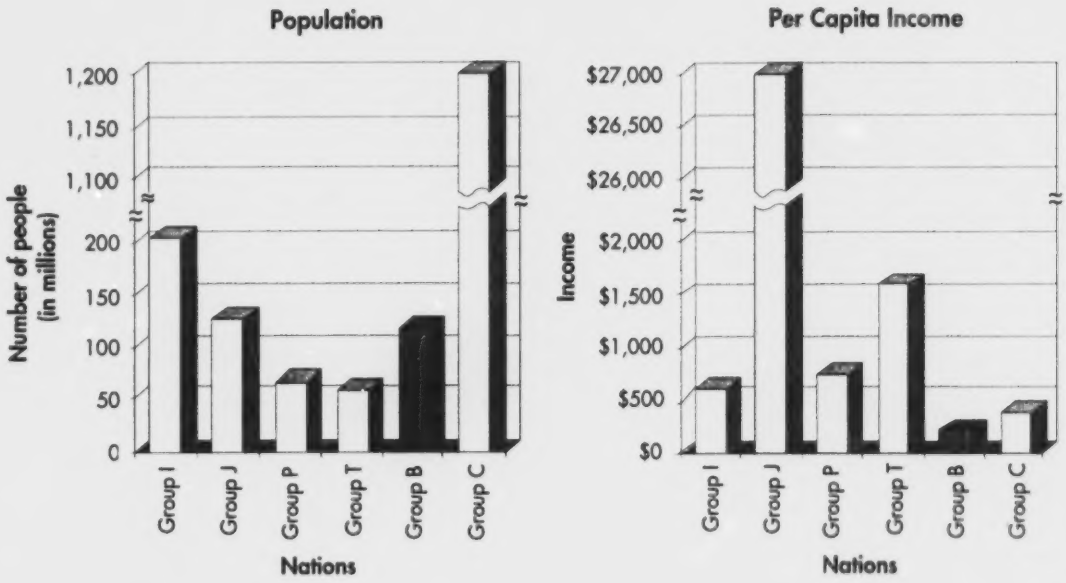
Government Official: is concerned about feeding people now and would like to have the economy of the country grow; that is, the government wants to get a lot of product, money, or food with little investment of resources or money. This person also has the task of listening to everyone else and making the final decisions.

Farmer: wants to grow as much rice as possible with as much help as possible because she/he depends on the rice for food and money to survive. The farmer realizes that good care, clean water, and sunlight are important to the growth of the rice plants. This person also realizes that, for one reason or another, not all seeds sprout.

Environmental Scientist: is concerned about the long-term effects of doing things that will harm the land, the water, the air, the wildlife, and ultimately the people of the country. The scientist realizes that too many chemicals will harm the land. This person seriously considers the effects of decisions many years after the decisions are made. The scientist is an advisor in the national decision making.

Citizen: wants to have enough to eat and enough money and resources in the country to live comfortably. This person is concerned that the benefits and costs of food production are shared equally among all the people in the country.

COUNTRY INFORMATION SHEET
GROUP B



Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
  information about how best to grow your rice

Some information that might be helpful:

- Total population: 115 million people
- Total amount of land: 50,000 square miles
- Number of people per square mile of land: 2,300
- In the year 2050, scientists think your population will be 165 million people
- In a year, the average person in your country earns $220

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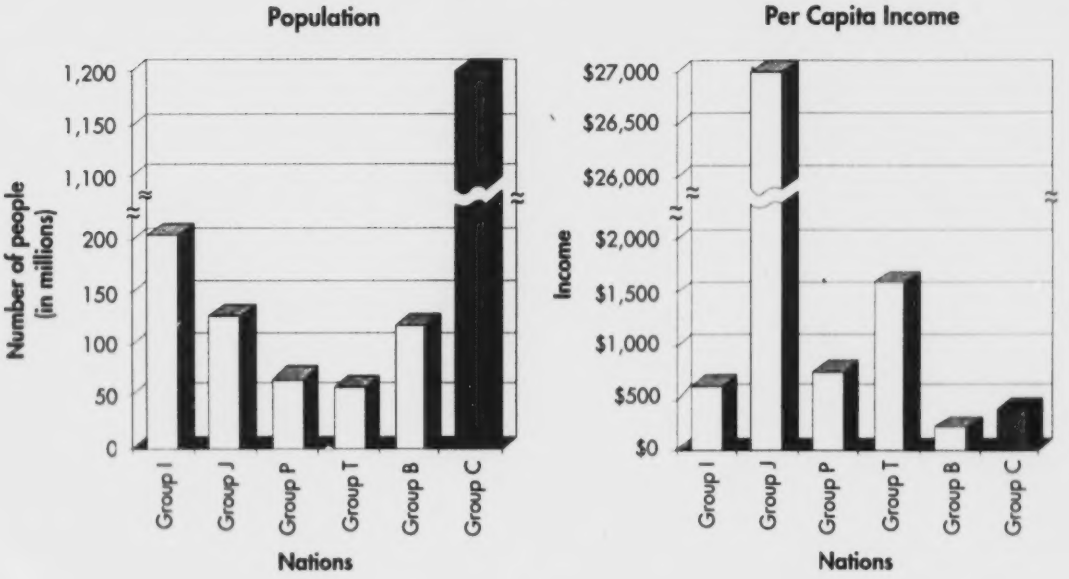
COUNTRY INFORMATION SHEET
GROUP C



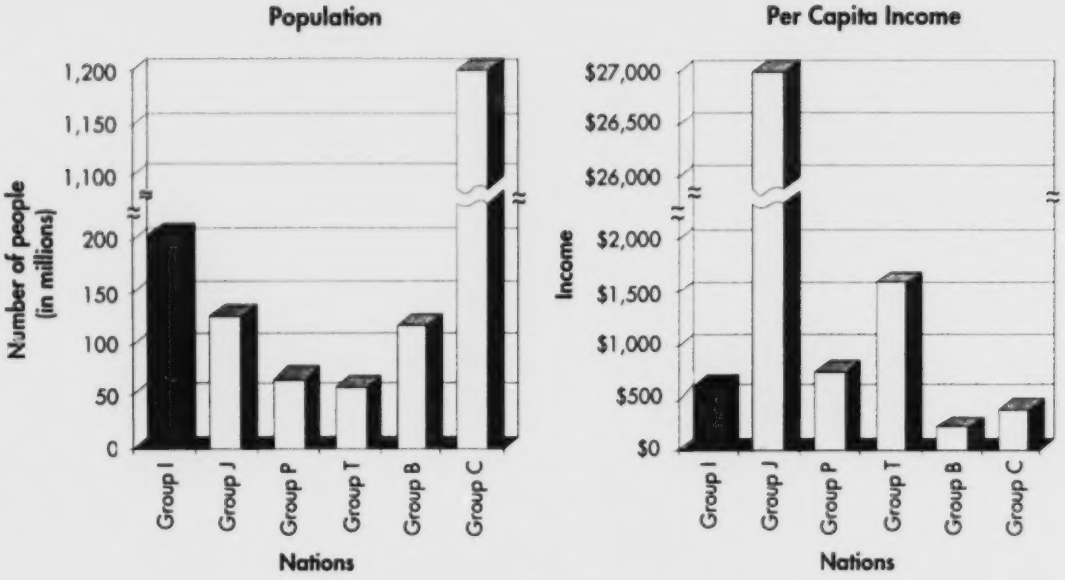
Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
- information about how best to grow your rice

Some information that might be helpful:

- Total population: 1.2 billion people
- Total amount of land: 3,600,000 square miles
- Number of people per square mile of land: 330
- In the year 2050, scientists think your population will be 1.4 billion people
- In a year, the average person in your country earns $370

COUNTRY INFORMATION SHEET
GROUP I



Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
- information about how best to grow your rice

Some information that might be helpful:

- Total population: 200 million people
- Total amount of land: 700,000 square miles
- Number of people per square mile of land: 250
- In the year 2050, scientists think your population will be 240 million people
- In a year, the average person in your country earns $610

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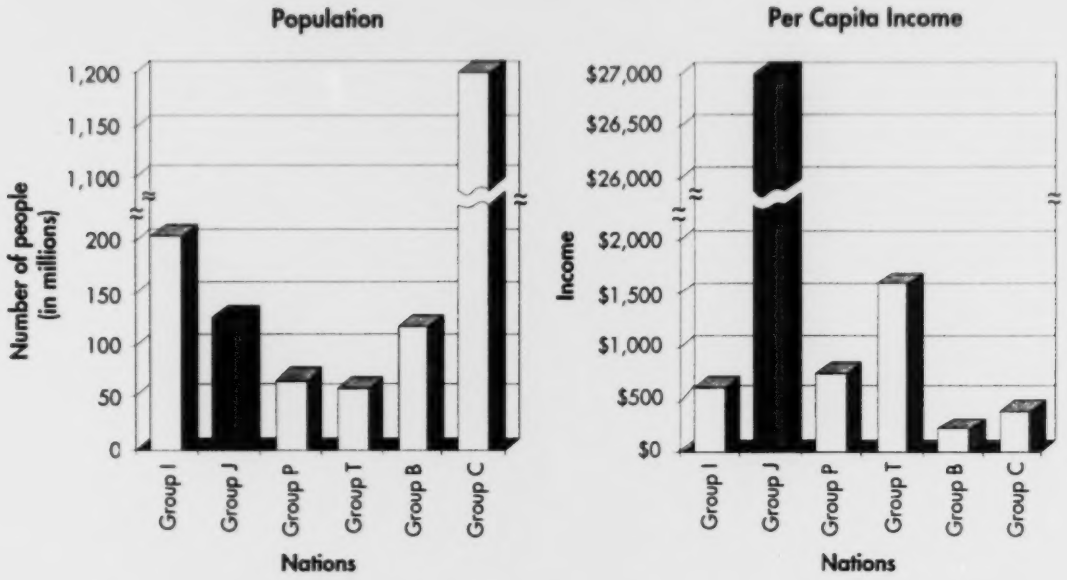
COUNTRY INFORMATION SHEET
GROUP J



Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

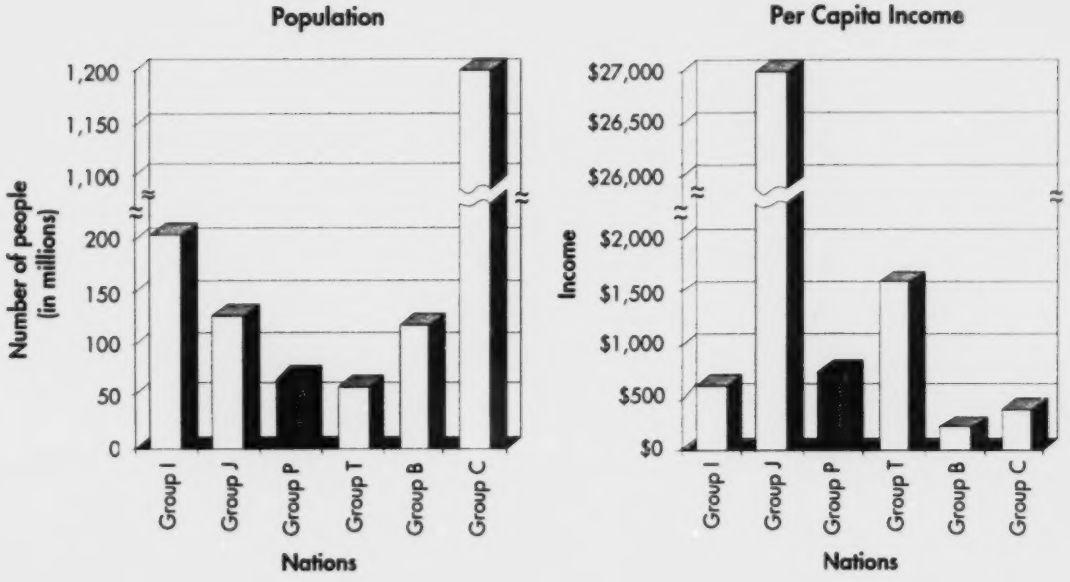
- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
- information about how best to grow your rice

Some information that might be helpful:

- Total population: 125 million people
- Total amount of land: 145,000 square miles
- Number of people per square mile of land: 860
- In the year 2050, scientists think your population will be 130 million people
- In a year, the average person in your country earns $27,000

country information sheet p

Country Information Sheet
Group P



Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
- information about how best to grow your rice

Some information that might be helpful:

- Total population: 65 million people
- Total amount of land: 115,000 square miles
- Number of people per square mile of land: 560
- In the year 2050, scientists think your population will be 86 million people
- In a year, the average person in your country earns $730

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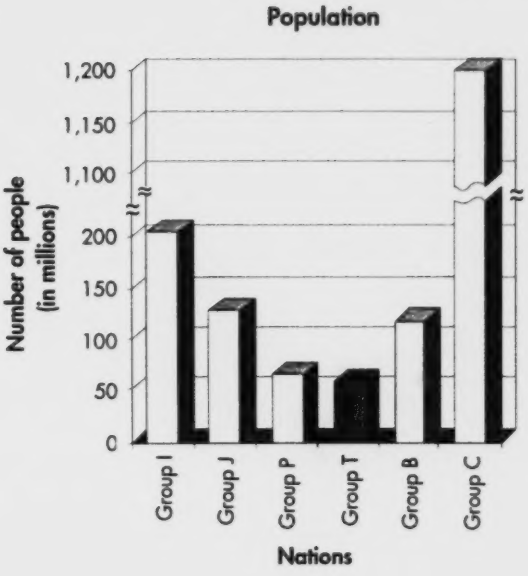
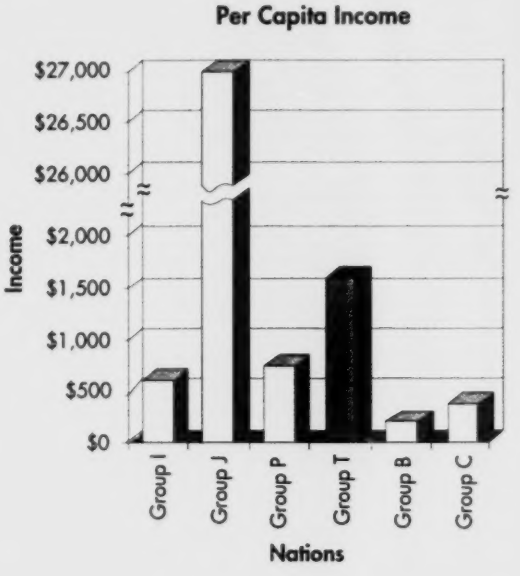
COUNTRY INFORMATION SHEET
GROUP T





Object of the task for your group: grow enough food to feed the people in your country. At the end of the unit, the year will be 2050, and you will have the opportunity to see the consequences of your decisions today. In order to plant your crop, you will need the following materials:

- enough soil to fill your container(s)
- as many seeds as you think you need (1 seed represents enough rice to feed 10 million people)
- water and care (each group has one care schedule card)
- a good place to grow your crops
- anything that might help your crop grow better
- information about how best to grow your rice

Some information that might be helpful:

- Total population: 57 million people
- Total amount of land: 200,000 square miles
- Number of people per square mile of land: 300
- In the year 2050, scientists think your population will be 70 million people
- In a year, the average person in your country earns $1,600

Money Tokens

International Currency	International Currency	International Currency	International Currency	International Currency
International Currency	International Currency	International Currency	International Currency	International Currency
International Currency	International Currency	International Currency	International Currency	International Currency
International Currency	International Currency	International Currency	International Currency	International Currency
International Currency	International Currency	International Currency	International Currency	International Currency
International Currency	International Currency	International Currency	International Currency	International Currency

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CARE SCHEDULE CARDS

Care Schedule Card #1 Water every day. Put plants outside once a week.	**Care Schedule Card #2** Water every other day. Put plants outside once a week.
Care Schedule Card #3 Water every day. Put plants outside every day.	**Care Schedule Card #4** Water every other day. Put plants outside every day.
Care Schedule Card #5 Water every day. Put plants outside every other day.	**Care Schedule Card #6** Water every other day. Put plants outside every other day.

DIPLOMAT TAGS

DIPLOMAT *Country B*	**DIPLOMAT** *Country J*
DIPLOMAT *Country C*	**DIPLOMAT** *Country P*
DIPLOMAT *Country I*	**DIPLOMAT** *Country T*

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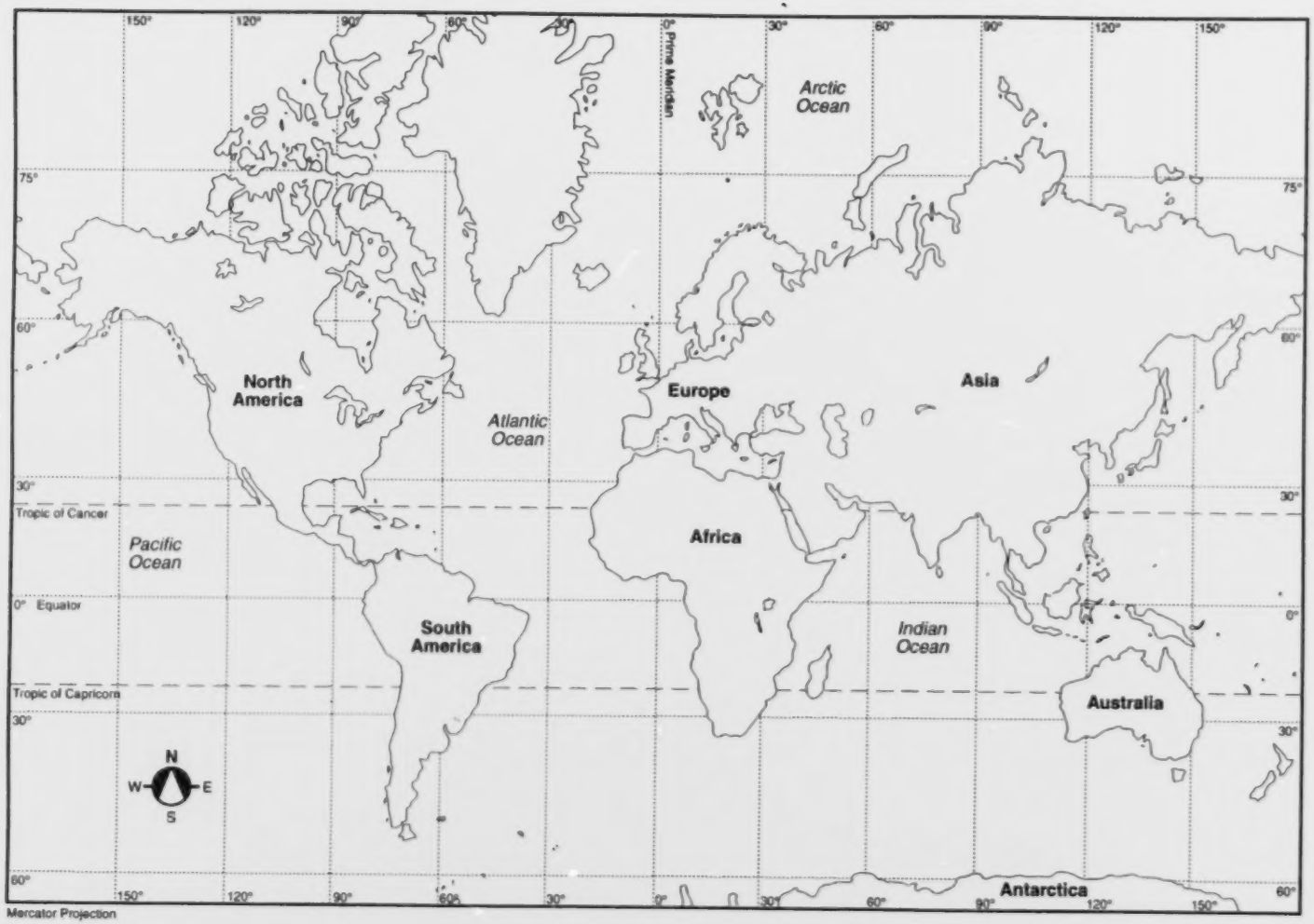
WORLD MAP

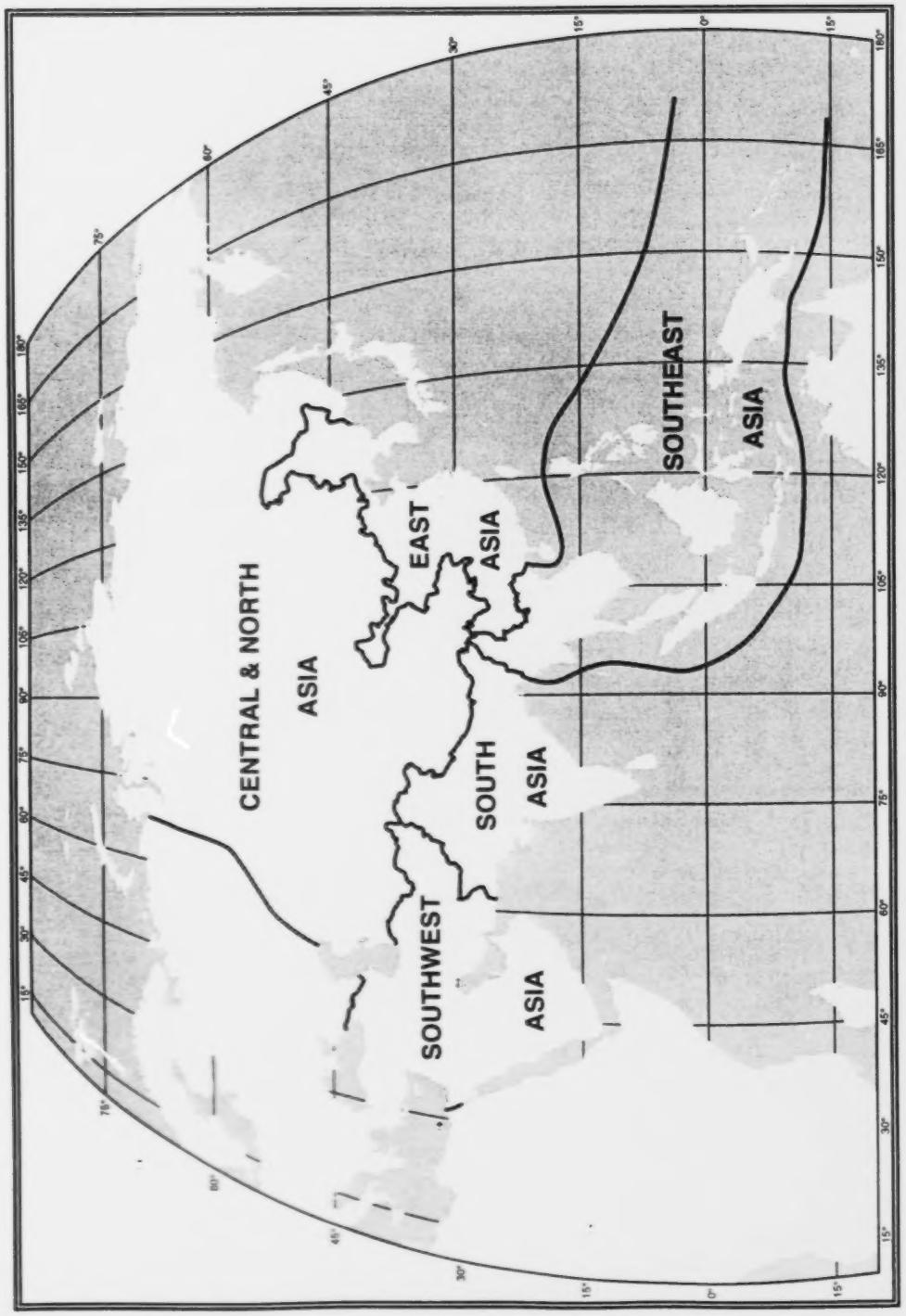


Mercator Projection

transparency

BEST COPY AVAILABLE

MAIN GEOGRAPHICAL AND POLITICAL REGIONS OF ASIA



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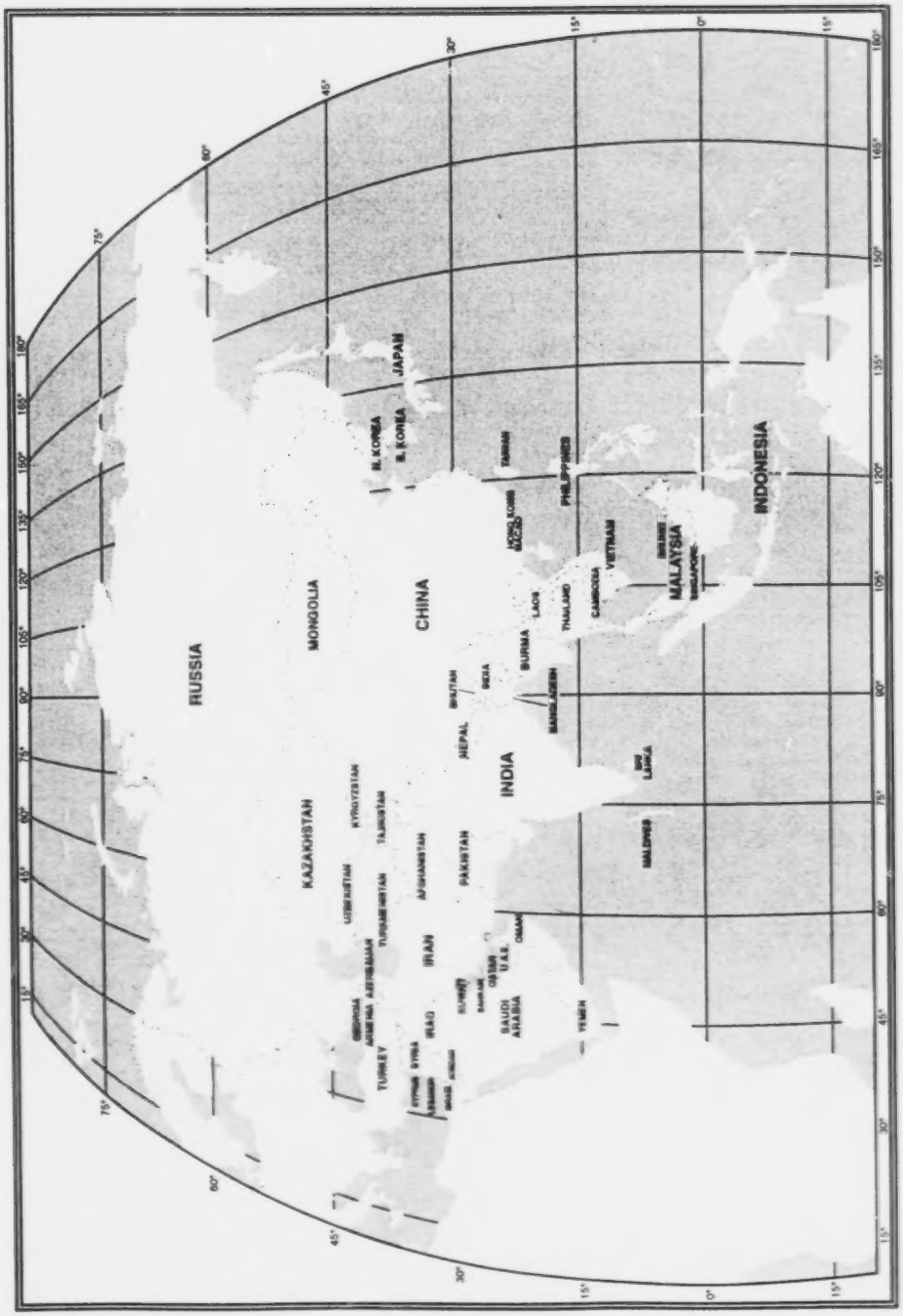
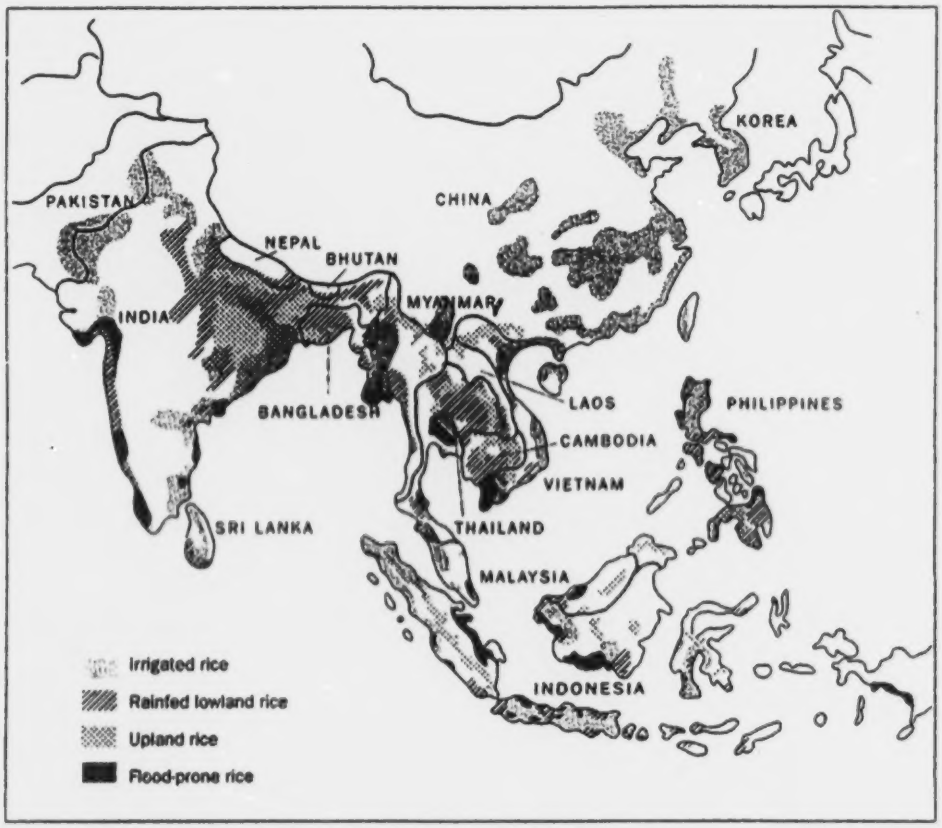
POLITICAL MAP OF ASIA



MAP OF RICE-GROWING REGIONS OF ASIA



Source: International Rice Research Institute, *Rice Research in a Time of Change: IRRI's Medium Plan for 1994–1998*. Manila, Philippines: IRRI, 1993.

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Lesson 2

THE HISTORICAL AND CULTURAL IMPORTANCE OF RICE

A STUDY OF SIX COUNTRIES

Organizing Questions

- What does some of the research on the origins and diffusion of rice tell us about the historical importance of rice?
- What is the cultural importance of rice in Asia?

Introduction

> In Asia, rice is more than a mere food, though it does provide the main source of calories for 2.7 billion people. The Emperor of Japan is the living embodiment of the God of the ripened rice plant. In Balinese myth, Lord Vishnu created rice, and God Indra taught mankind how to raise it. The more prosaic Chinese believe man was introduced to rice by a dog. They have a saying that "the most precious things are not jade and pearls, but the five grains," of which rice is the first. ("The Future Written in a Grain of Rice," *The Economist*, March 9, 1991.)

Production and consumption statistics tell us that rice is a major staple crop in Asia and the Pacific, but they tell us very little about the historical or cultural importance of rice in the many and varied countries where it is grown and consumed. Lesson 2 begins with a brief overview of the origin and diffusion of rice. The second part of lesson 2 provides students with the opportunity to begin exploring the cultural values of rice in Bangladesh, China, Indonesia, Japan, Philippines, and Thailand.

Through literature, folktales, storytelling, Chinese characters, poetry, and personal narrative, students can begin to get a picture of the crucial role of rice in the life and culture in these countries. It is important to acknowledge that the activities present only isolated pieces of very rich, dynamic, and complex cultures, but ideally, the experiences will serve as entryways into an exploration of these Asian and Pacific cultures.

After a brief activity on the origin and diffusion of rice cultivation in Asia and the Pacific, small groups will work on one of six activities corresponding to the six countries introduced in lesson 1. Each activity is designed to stand on its own and take approximately two class periods, but you may want to give groups the opportunity to experience more than one and up to six activities by rotating through "rounds" of activities.

lesson two

Objectives

knowledge

- to understand the basic aspects of the origin and diffusion of rice
- to recognize rice as having nutritional, economic, historical, and cultural importance for the people of different countries of Asia
- to make connections between the complex factors in rice production on an economic or environmental level and the role played by rice in culture

attitude

- to appreciate the diversity and complexity of cultures in Asia
- to gain an understanding of some of the feelings that rice evokes

skill

- to work effectively in small groups
- to express ideas creatively

Materials

- World Map, overhead transparency (from lesson 1)
- World Map, one per small group (from lesson 1)
- Four Questions, transparency
- Four Questions Answer Sheet, for the teacher
- Handout #1 : Origin and Diffusion of Rice
- Activity #1 : Rice in China, one copy; one large sheet of newsprint
- Activity #2 : Rice in Thailand, one copy; one large sheet of newsprint or posterboard
- Activity #3 : Rice in Indonesia, one copy; one shoebox
- Activity #4 : Rice in Japan, one copy; six sheets of 8.5 X 11 inch cardstock
- Activity #5 : Rice in the Philippines, one copy
- Activity #6 : Rice in Bangladesh, one copy; one sheet of newsprint
- Overhead projector

This lesson engages students in a variety of activities based on readings. Readings have been carefully selected to reflect the historical and cultural importance of rice in the six countries under study and to provide for a range of reading levels among students. The following is a rough hierarchy of the reading selections contained in this lesson (listed from the most difficult):

- literature excerpt from Thailand
- folktale and poetry from China
- short story from Indonesia
- personal narrative from Bangladesh
- legend from the Philippines
- folktale from Japan

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Procedure

1. Review lesson 1 and point out that the simulation focused on the importance of rice as an economic resource, a means for resolving hunger, and a potential environmental issue. The end of lesson 1 looked at the climatic reasons rice is grown in Asia and the Pacific. Explain that in this lesson, students will examine the importance of rice historically and culturally.

2. To begin this lesson, show the transparency, Four Questions, using an overhead. Have students volunteer possible responses to each of the four questions. Answers for the questions are provided for the teacher on page 38.

3. For further information about the history of rice, distribute copies of Handout #1: Origin and Diffusion of Rice, to small groups of 3–4 students. Also give each group a copy of the World Map, provided in lesson 1. Have students read through the handout and discuss the task on the second page of the handout.

Using the World Map overhead transparency from lesson 1, have students describe the origin and diffusion of rice based on Handout #1.

4. Explain that the next small group activities will enable students to explore the importance of rice in the different cultures of Asian rice-growing countries. Distribute one of the Activities #1–6 to six groups of students, taking care that each group has a different country from the one they played in the simulation, unless you plan to have students rotate through the activities. The composition of groups may be different from those in lesson 1, but keeping the same groups allows the students to learn to work together on a variety of different tasks. Allow 1–2 class periods for these activities.

5. Each group should share its group project with the rest of the class. Allow approximately 10 minutes for each group. Debrief the activities by reinforcing the following points:

   - Rice in China: Aspects of the Chinese language and examples of poetry and folktales from China reflect the importance of rice in everyday life.
   - Rice in Thailand: The contrasts between the lives of rice farmers in Thailand in different areas of the country and those of urban dwellers are illustrated through the literature excerpts from *Rice Without Rain*.
   - Rice in Indonesia: "The Story of Rice" has its origin in Hindu beliefs and tells about the beginnings of rice cultivation in Indonesia by earth-bound humans.

- Rice in Japan: In numerous Japanese folktales, rice symbolizes prosperity, strength, and the "good life."
- Rice in the Philippines: The rice terraces of the Ifugao Province in the Philippines have stood as monuments to the ingenuity and resourcefulness of the Ifugao people for over 3,000 years.
- Rice in Bangladesh: The role of women in rice production is crucial in all parts of Asia and the Pacific.
- It is important to acknowledge that these readings represent only isolated pieces of rich, changing, and complex cultures.

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FOUR QUESTIONS

How long ago do you think rice was first grown by people? a. 50 –100 years ago b. 300 –500 years ago c. 1000–2000 years ago d. 7000 –10,000 years ago	Where do you think rice was first grown and eaten? a. what is now Japan b. what is now Egypt c. what is now China d. what is now Australia
Which of the following countries are the five largest producers of rice in the world? a. United States b. Indonesia c. Brazil d. Vietnam e. Thailand f. Myanmar g. Japan h. India i. China j. Bangladesh	Which of these crops is rice related to? (one or more) a. asparagus b. wheat c. barley d. corn

FOUR QUESTIONS ANSWER SHEET

How long ago do you think rice was first grown by people?

d. 7000-10,000 years ago

Archeological research in Asia has found that rice was cultivated by humans as early as 5000 to 8000 B.C. Many of the techniques used by rice farmers today, like transplanting young rice plants into wet paddies, were first developed thousands of years ago. The tradition of growing rice has a long history that is strongly interwoven in the culture of each rice-growing country. Over one-third of the world's population today depends on rice as its primary staple food.

Where do you think rice was first grown and eaten?

c. what is now China

Although no one knows for sure, scientists believe that Asian rice originated in an area that runs along South China and Southeast Asia. Because people in 5000 B.C. had little control over the environment, the climate in this area must have been particularly good for rice cultivation—warm and humid climate with definite monsoon seasons and not too much sun. The production of rice spread south and east to Thailand, Indonesia, and India. A bit later, rice cultivation was transmitted to Korea and to Japan.

Which of the following countries are the five largest producers of rice in the world?

i. China
h. India
b. Indonesia
j. Bangladesh
d. Vietnam

1993 rice production statistics:
China: 187,211,000 tons
India: 111,011,000 tons
Indonesia: 47,885,000 tons
Bangladesh: 28,000,000 tons
Vietnam: 22,300,000 tons
Thailand: 19,090,000 tons
Myanmar: 17,434,000 tons
Brazil: 10,193,000 tons
Japan: 9,793,000 tons
United States: 7,081,000 tons
The largest rice-producing country in Africa is Egypt, which produced 4,159,000 millions tons of rice in 1993.

Which of these crops is related to rice?

b. wheat
c. barley

Rice, wheat, and barley are all grains or cereals and are in the same scientific "family." Rice and wheat are the most important cereals produced in the world, but they grow in very different environments. Wheat is grown mostly in temperate zones (like the Midwest of the United States), and much of it is traded internationally. Rice, on the other hand, grows mostly in tropical zones, and 90 percent of all rice is produced and consumed in Asia.

ORIGINS AND DIFFUSION OF RICE[1]

While reading this handout, prepare to discuss and describe the origin and diffusion of rice, utilizing the information in this handout and a world map provided by your teacher.

The origins of rice have long been debated. The plant is so old that the exact time and place of its first development will perhaps never be known. It is certain, however, that domestication of rice ranks as one of the most important developments in history. Rice has fed more people over a longer period of time than has any other crop.

The most convincing archeological evidence for domestication of rice in Southeast Asia was discovered by Wilhelm G. Solheim II in 1966. Pottery shards bearing the imprint of both grains and husks of *Oryza sativa* were discovered at Non Nok Tha in the Korat area of Thailand. These remains date from at least 4000 B.C. This evidence not only pushed back the documented origin of cultivated rice but, when viewed in conjunction with plant remains from 10,000 B.C. (discovered in Spirit Cave on the Thailand-Myanmar border), also suggests that agriculture itself may be older than was previously thought.

Early Spread of Rice

From an early beginning somewhere in South or Southeast Asia, the process of diffusion has carried rice in all directions until today it is cultivated on every continent except Antarctica. In the early Neolithic era (a period of time beginning about 10,000 years ago), rice was grown in forest clearings under a system of shifting cultivation. The crop was direct seeded, without standing water—conditions only slightly different from those to which wild rice was subject. A similar but independent pattern of the incorporation of wild rices into agricultural systems may well have taken place in one or more locations in Africa at approximately the same time.

Puddling the soil and transplanting seedlings were likely refined in China. Both operations became integral parts of rice farming and remain widely practiced to this day. Puddling breaks down the internal structure of soils, making them much less subject to water loss through percolation. In this respect, it can be thought of as a way of extending the utility of a limited water supply.

Transplanting is the planting of 1- to 6-week old seedlings in puddled soil with standing water. Under these conditions, the rice plants have an important head start over a wide range of competing weeds, which leads to higher yields.

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[1] adapted from International Rice Research Institute, *IRRI Rice Almanac*, Manila, Philippines: IRRI, 1993.

Transplanting, like puddling, provides the farmer with the ability to better accommodate the rice crop to a finite and fickle water supply by shortening the field duration (because seedlings are grown separately and at a higher density) and adjusting the planting calendar.

With the development of puddling and transplanting, rice became truly domesticated. In China, the history of rice in river valleys and low-lying areas is longer than its history as a dryland crop. In Southeast Asia, however, rice originally was produced under dryland conditions in the uplands, and only recently came to occupy the vast river deltas.

Migrant people from South China or perhaps northern Vietnam carried the traditions of wetland rice cultivation to the Philippines during the second millennium B.C., and Deutero-Malays carried the practice to Indonesia about 1500 B.C. From China or Korea, the crop was introduced to Japan no later than 100 B.C.

Movement to western India and to Sri Lanka was also accomplished very early. Rice was a major crop in Sri Lanka as early as 1000 B.C. The crop may well have been introduced to Greece and the neighboring areas of the Mediterranean by returning members of Alexander the Great's expedition to India around 344-324 B.C. From a center in Greece and Sicily, rice spread gradually throughout the southern portions of Europe and to a few locations in North Africa.

Spread of Rice to North and South America

The Portuguese carried rice to Brazil, and the Spanish introduced its cultivation to several locations in Central and South America. The first record of rice production in North America dates from 1685, when the crop was produced on the coastal lowlands and islands of what is now South Carolina. The crop may well have been carried to that area by slaves brought from the African continent. Early in the 18th century, rice production spread to Louisiana, but not until the 20th century was it produced in California's Sacramento Valley. The introduction into California corresponded almost exactly with the timing of the first successful crop in Australia's New South Wales.

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RICE IN CHINA

Chinese Characters, Folktales, and Poetry

Archaeological discoveries have proven that the Chinese had a written language as early as 4,000 years ago. This written language, based at first on actual objects and later on abstract concepts, has developed into the highly stylized characters of today. Since ancient times, the art of writing has been highly valued in Chinese culture. The gracefully formed characters of Chinese calligraphy are often displayed on walls as art forms.

Poetry in China reflects much of the values and sentiments of traditional Chinese culture at different points in history. Most of the poetry from earlier times was written by the well-educated men in China, many of whom were officials in the huge and complex government. The poem on page 46 was written by one such scholar-official who lived in the Sung dynasty, which lasted from 960–1279. Su Tung-p'o is respected as one of the greatest poets of that time. Like many scholars throughout Chinese history, he often criticized the policies of the government and was exiled twice for his opinions. The poem was written during his first period of exile.

Read the following sections: (1) Chinese Characters; (2) the story "The Choosy Maid of Yen-Pien"; and (3) the poem "Eastern Shore," written by Su Tung-p'o. Discuss the following questions with your group:

1. Why is rice important in Chinese culture?
2. How can you see this influence in some Chinese characters? in the story, "The Choosy Maid of Yen-Pien?"
3. What does the poem tell you about growing rice?
4. What kinds of feelings does Su Tung-p'o have about rice?
5. Why would someone write a poem about growing rice?

Group Task

Create a group poem (or lyrics to a song), expressing some of the reasons for valuing rice in China. Write this on a large sheet of newsprint. Use the Chinese characters for rice, rice field, and related words. Be ready to present your poem to the class.

activity #1

Chinese Characters

The Chinese written language was one of the first developed in human history. Over 4,000 years ago, the Chinese were using pictorial signs—pictographs—to represent the objects or ideas they wanted to communicate. Over time, the pictographs have became more systematized and less pictorial, developing into the over forty thousand characters that make up modern written Chinese. Knowledge of roughly five thousand of these are sufficient, though, for the average person.

Since ancient times, the art of calligraphy has been highly valued in Chinese culture. The elegant strokes of the brush express the rhythm and flow of "life-movement" captured on paper.

The character for rice was originally a drawing of the rice plant itself, with its long stem, leaves, and roots growing into the ground. The modern character for rice is:

Similarly, the character for field first depicted the even rows of the rice paddy. This picture can still be seen in the modern character:

More complex objects or ideas were expressed by combining the pictographs. For example, the character for tree (木) can be combined with other trees to mean forest (林). These small characters that make up the new character are called "radicals."

If (力) means strength, we combine it with (田) to mean "manly" or "masculine" （男） because the ancient Chinese expected that the role of the man was to spend all day working hard in the fields.

Another example is:

character	first radical	second radical	meaning
東	sun	tree	sun rising behind a tree: EAST

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The following Chinese characters will appear in the story, "The Choosy Maid of Yen-Pien:"

character	pronunciation	meaning
女	nü	woman; women; female
米	mi	rice (uncooked)
男	nan	man; men; male; manly
田	tian	field; rice paddy
日	ri	sun
東	dong	east
水	shui	water
山	shan	mountain(s)
木	mu	tree; wood
力	li	strong; strength

The following story will enable you to practice reading the Chinese characters explored in the previous section. This story is from the Yen-Pien Korean Autonomous District in northeast China where minority Korean Chinese live. They are one of the many minority groups that live within China and in total, make up some 6 percent of the population—that is, more than 55 million people. Although most people in China are Han, or ethnic, Chinese, the origins of this story remind us of the diversity of cultures and people in China.

The Choosy Maid of Yen-Pien[1]

In ancient China, there lived in what is present-day Yen-Pien a Korean 女 whom all people envied and admired. She could work better and more quickly than anyone in the land.

In a morning she could stem her raw hemp, separate the fibers, spin them into thread, and weave the threads into linen finer than the finest silk. So swiftly did her fingers work that she still had time to cook 米, put it in a wooden box, cover it with the cloth she had woven, and carry it all for breakfast to the 男 working in the 田. She was famous throughout the land for thousands of *li*, and many a young 男 tried to marry her. The matchmakers almost wore out the doorsill of her front door, but she would have none of the suitors.

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[1] from Weng, Virginia and M. A. Jagendorf. "The Choosy Maid of Yen-Pien." In *The Magic Boat and Other Chinese Folk Stories.* New York: Vanguard Press, 1980.

activity #1

One day a fine young 男 from a faraway village came to woo her. He said he could work as well as she could. He could plant ten *mu* of 米 in a single morning.

"I would like to see you do it."

"I will come tomorrow and you will see."

The next morning, just as the gleaming 日 rose in the 東, he was there and began planting the seedlings without stopping. On and on he worked, and when the 日 had climbed to the center of the sky, before the dew was even dry, he had planted ten *mu* just as he said he would.

When the 女 came to inspect the 田, the young 男 turned around to look for his straw hat. He was so set on his work that he had forgotten he had put it down in the 田.

The 女 looked at him and smiled.

"You are a good worker," she said, "but you left out this spot that was covered by your hat. Your work is not good enough for me, and I will not marry you."

The poor disappointed young 男 left in a huff.

Not long after, another young 男 arrived, handsome and 力, to woo the 女. He, too, said he could plant ten *mu* of 米 in just half a day.

Again she said, "I would like to see you do it."

"I will tomorrow."

The next day came and so did the young 男. He began working, planting, and working. The 日 reached the middle of the sky, and ten *mu* were planted. The 女 came and examined the work.

"Yes, I see ten *mu* of 米 seedlings planted, but I also see one unplanted seedling floating on the 水."

"Yes," said the young 男, "I forgot one of the seedlings."

"Young 男,"she said, "you forgot one of the seedlings, and that means your work is not good enough. I will not marry you."

After that the Korean young 男 of China were afraid to ask for the 女 and none came.

Life for her at home became lonely, and so she decided to go out into the land to see if she could find the right 男 for her. She roamed about for some time, and one day, while crossing the top of a 山, she met one of the young 男 she had refused. He was still angry, and when she came face to face with him on the narrow path, he pushed her off the cliff on which she was standing.

At that moment a young blacksmith in the village below was hammering out a scythe. Seeing the falling 女, he finished the scythe and dashed to the foot of the 山. Quicker than a flash of lightning he cut off a mess of twigs from a 木, wove them into a basket, and held it under the falling 女. She fell right in without a scratch.

She jumped out of the basket and cried, "You saved my life!"

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He was big and 力 and 男. She looked at him and cried, "Perhaps you are the 男 for whom I have been looking!"

He recognized who she was—the outstanding 女 in all the northeast.

"You will make a fine wife," he said.

"And I think you will make a fine husband."

So they were married and were happy ever after.

"EASTERN SHORE," A POEM BY SU TUNG-P'O[2]

I planted rice before Spring Festival
and already I'm counting joys!
Rainy skies darken the spring pond;
by green-bladed paddies I chat with friends.
Transplanting takes till the first of summer,
delight growing with wind-blown stalks.
The moon looks down on dew-wet leaves
strung one by one with hanging pearls.
Fall comes and frosty ears grow heavy,
topple, and lean propped on each other.
From banks and dikes I hear only
the sound of locusts like wind and rain.
Rice, newly hulled, goes to the steamer,
grains of jade that light up the basket.
A long I've eaten only government fare,
old rusty rice no better than mud.
Now to taste something new—
I've already promised my mouth and belly.

Su Tung-p'o (1037-1101)
(acknowledged as the greatest poet of the Northern Sung Period)

This poem is the third in a series of eight describing a small farm at a place called Eastern Slope (Tung-p'o) in Hupei, where the poet lived in exile after his release from prison for criticizing government policy.

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[2] from Watson, Burton, ed. *The Columbia Book of Chinese Poetry*. New York: Columbia University Press, 1980.

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RICE IN THAILAND

Literature from Thailand

Over two-thirds of Thailand's 56 million people are farmers, most of whom grow rice in the fields of the central plains, the north, and the northeast. In comparison to farmers in the fertile central plains, the rice farmers in the Northeast must cope with mountainous land, drought, and greater poverty. The contrasts between the lives of the rice farmers in different areas of the country and those of the urban people are great. Thai literature eloquently expresses the importance of rice in Thai culture, its role in history, and the experiences of individuals from vastly different backgrounds.

As in many other countries, the 1960s and 1970s were turbulent times for Thailand. The student movement of 1973-1976 in Thailand was a period of great idealism as well as terrible violence. The students in the cities were inspired by the poverty around them and the plight of the rice farmers in the country to begin building a new Thailand. As urban residents, though, the students' lives were far removed from those of the rural farmers. The following excerpts from the novel *Rice without Rain*, written by Minfong Ho, describe Jinda, the daughter of a rice farmer in a small village, and her experience as she meets the challenge of a rapidly changing world.

Read the story excerpts, and together with your group, discuss the following questions:

1. What is the importance of rice to the farmers?
2. What is the significance of rice to the students?
3. What are the students trying to do? What are the protests for? Are these causes you would support?
4. Do you think the students are successful in the end?
5. What are the lives of the farmers like in the end?

Group Task

Your group task is to focus on one or more of the excerpts in the reading and create a mural depicting the main themes and your collective ideas about the outcome of the story. Where might the main characters be and what might they be doing today?

activity #2

Characters:

Jinda	Main character, 17-year-old girl, daughter of a rice farmer who is the village headman (Inthorn)
Inthorn	Village headman
Dao	Jinda's sister
Ned	Leader of the students from Bangkok
Sri	Medical student from Bangkok who is around Jinda's age and stays with her family

Like rice without rain
We wilt in the parched fields,
Waiting to die a slow death
While others drain off our water.
Like the rice, like the wilting rice
We live waiting for the rain.
(adapted from a Thai folksong)

The song was the song of rice. It sang of the sowing of the unhusked seed rice and of the careful transplanting of seedlings from seedbeds to newly plowed fields. It sang of months of weeding, of watering, of waiting as the stalks grew tall and green, and then ripened into a dry brown. It sang of the days spent harvesting and threshing, winnowing and milling the grain—all to fill a single rice bowl.

Each grain of rice is a bead of sweat.
Each bead of sweat is a drop of pain.
What fills the rice bowls of the rich?
The sweat of our brow, the blood in our veins.

The song rippled outward, so that the night air seemed to pulse with its rhythm. Then the last note died away, low and solemn. Nobody moved. The circle of faces around the firelight glowed like embers fanned by a gust of wind.

Jinda, too, sat absolutely still. The song had struck a deep chord in her, as if something long dormant had now stirred. There was pain in that song, a pain that had taken on new dignity because it had been given shape and acknowledged.

Nor was Jinda the only one to be so affected. She saw her father stare at the young stranger with a dazed expression. Then Inthorn reached over and took the stranger's hand. He held it up toward the firelight and studied the palm for a long moment.

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"I don't understand," Inthorn said at last. "Your hand is smooth and soft, a student's hand. Yet your song," he shook his head in wonder, "your song is a farmer's song. It sings of our life. How could you know what it is like for us?"

"The song was written by a man called Jit Pumisak," the stranger replied. "Jit was from a noble family in Bangkok but chose to spend his life working among poor farmers in the Northeast. We have learned many of his songs, but we still don't know much of the life of the Thai farmers. That is why we are here. We hope to learn from you."

[The students are Ned, the student leader from Thammasart University, Sri, a medical student from Mahidol, and two other university students.]

Dao spoke up then, her voice as soft as the night wind. "He doesn't want rice gruel, and he won't try to breastfeed now," she said softly. "And he never smiles when I sing to him anymore."

Sri's hands moved over the baby, probing, stroking, examining.... Her hands strayed over the baby's bloated stomach, up his ribs, and to his thin stem of a neck. "Kwashiorkor," she said. "Marasmic kwashiorkor. So malnourished he doesn't have the strength to fight a simple infection." She looked up at Dao. "What do you feed him?" she asked.

Dao chewed at her underlip. "I ... I do my best," she faltered. "Rice porridge mostly, and some mashed bananas when we have any..."

"Any milk?"

Dao turned her face away. "My milk ran dry weeks ago," she murmured, her voice low with shame.

"But your baby needs protein, and—"

"Oh, give him some then, please!" Dao eyed the bottles of medicine lined up neatly on the table.

"But I can't, it is..."

"Please, just a little?"

"You don't understand," Sri said, biting her lips. "Protein is not medicine. It is meat, fish, milk...."

"Meat?" Dao echoed, bewildered. "And fish?"

The two young women stared at each other for a long moment. Finally Jinda's grandmother spoke.

"We have no meat, no fish, no milk," she said abruptly. She relit her cigar with a twig dipped into the lamp and took a long puff from it. "When the paddies are knee-deep in rainwater, we can catch snails or soft-shelled crabs, and even some catfish." She blew out a stream of smoke and continued dreamily. "Or in the winter, we can go into the forest and find pink and white mushrooms under moist ferns, or cut the spikes of newly sprouted bamboo shoots from the groves." She tapped the ash off

her cigar. "But what is there now when the fields are cracked and hard and the mountainsides barren? Don't talk to us of meat and fish, child. We are hungry, all of us, but the little ones most of all...."

"Tetracycline, penicillin, ampicillin...all this medicine," Sri said, putting the last bottle in the box. "All this medicine, and what use is it?" "Can doctors heal hunger, Jinda?" she asked quietly. "Will any amount of penicillin cure poverty?"

Slowly, Inthorn squatted down by the mound of rice grain that had been threshed from his two plots of rice. As if oblivious to the people pressed around him, he scooped up a handful of rice and let the unhusked brown grain trickle through his fingers.

"Fifty years now," he said to no one in particular, "I have grown rice in these fields. And for fifty years, I have seen half of my crop carried off."

He looked up at the fields that stretched out before him, dry and stubbled in the sun. "I know every inch of these fields. I have plowed them and planted them, weeded them and fertilized them, harvested them and reaped the rice grain from them. I think of them as mine." His eyes lost their dreamy look and he scanned the faces of the people around him. "Brother Teep," he addressed his closest friend. "Your eight *rai* of land, do you think of them as yours?"

Lung Teep nodded.

"And Nai Tong, your land, do you think of it as yours?"

The second farmer nodded.

One by one, Inthorn turned to each of the farmers and asked the same question. And one by one, each answered in the same way.

"Well," Inthorn said finally. "It is not. That land out there belongs not to us but to some man who has never even held a crumb of soil between his fingers. A man who takes half of what we harvest, year after year." Inthorn let another handful of grain trickle through his fingers. Then he took a deep breath.

"Why?" he asked. "Why should we give him so much, when we don't have enough to feed ourselves and our children? Why are we so timid, so stupid, so tame?...."

"I have been like a buffalo all these years, placidly obeying my master every time he tugged at my rope." He drew himself straighter, and his glance swept past the people around him. "But no more. I am not a tamed buffalo. I am a man. I can choose what to do with my life. And this year, I choose not to pay the usual high rent."

[Inthorn gets arrested on a charge of cutting a single tree from land owned by the timber company (because refusing to pay full rent is not illegal). He attempts to flee, but is shot in the hand, and is imprisoned. Jinda

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is allowed to visit once, and sees her father in chains, severely ill, and not able to last much longer in prison. Ned, the leader of the students, convinces Jinda that the only way to save her father is to go to Bangkok and organize the big student movement there. Jinda goes to Bangkok.]

The train was approaching the outskirts of Bangkok now. Long lines of trucks drove by, piled high with baskets of cabbages, gunnysacks of rice, mounds of pomelos and tangerines. It seemed as if all the produce of the lush fields was being siphoned into the city.

"No wonder they call it the City of Angels," the farmer said softly, using the traditional name for Bangkok. "There is so much here, it must be like living in heaven."

They passed busy streets lined with storefronts. Huge glass windows displayed dresses, food, gleaming motorcycles, even sinks and toilets. Jinda grew dizzy just trying to see it all.

The other passengers in the train were stirring now. There was a sense of exhilaration as mothers hugged laughing children and men gestured at the scenes outside. A new life, the train seemed to be saying reassuringly, a new life, a good life.

Just then the train streaked past a dense, ugly section of huts. Bits of cardboard, warped planks, plastic sheets, and chicken wire were all thrown together as if a storm had pushed all the houses of a very poor village into one messy pile.

Jinda caught a glimpse of two girls squatting on a lopsided porch. They were brushing their teeth and spitting white foam into a swamp so putrid the water looked like tar. Jinda blinked several times before that cluster of huts flashed by....

"Last stop, Hualumporn Station in Bangkok," a voice announced over the loudspeaker.

At the edge of the station platform, Jinda saw a man asleep on a bench. His wife and brood of children huddled on the ground around him. They looked as if they had been camping at this spot for days. Their blankets were grimy with soot, their faces blank with exhaustion. Jinda stared. This was no trick of imagination.

Slowly, Jinda walked out the gate. On patches of lawn or around a bench just outside the station, many families huddled together. With a sinking feeling, Jinda realized that these were farmers like the family she had just met on the train, who had come down to make a living in the City of Angels.

Jinda took a long, hard look around her. The noise and exhaust of buses and trucks were overpowering. A veil of dust and smoke hung in the air, draping the early morning sunlight with gray. On the steps of the station

several children, thinner and much more ragged than her little brother, were selling garlands of wilted jasmine blossoms.

Jinda's mouth tightened into a grim line. So this was the City of Angels.

A roar of applause greeted her. She waited for it to die down before she began her speech.

"I am Jinda, daughter of Inthorn Boonrueng," she began. To her surprise she found that her voice was steady. In awe, she heard it reverberate from all corners of the square. Her words started to flow effortlessly from her, like a kite with a lovely long tail, tugging its way skyward as she held the string. She felt exhilarated and her voice grew stronger.

"My father has farmed all his life," she said, "and yet he has never had enough to eat. Why?" She paused, and in that brief silence she felt that maybe, just maybe she could help change a bit of Thailand after all. "Because he has had to pay half his harvest to the landlord. Year after year. Flood or drought."

"Commie!" A shrill voice pierced the air.

Startled, Jinda stopped.

"Keep talking!" Ned hissed.

Taking a deep breath, Jinda continued. Before she could finish her next sentence, another obscenity was flung at her. Shaken, she tried to continue talking.

A heavy object sailed toward her and landed where the shoeshine boy had been. There was a loud explosion. Bits of dirt and glass spewed out amid billows of smoke. People screamed and started to run.

Ned grabbed the microphone and urged the crowd to be calm. "Nothing serious has happened," he announced. "A small bomb has just been tossed at us. It hasn't hurt anyone. Do not panic. I repeat, do not panic. The speech will continue."

But some students near the podium started yelling and throwing rocks in the direction of the bomb. One even lobbed a homemade bottle-bomb at the soldiers massing at the far side of the square.

"Do not retaliate!" Ned was shouting from the podium. "Calm down. Do not fight back!"

But it was too late. Soldiers were fanning out in front of the ambulances, advancing toward the center of the square, pushing the crowd forward.

There was another bomb. It landed farther away from the speaker's platform, but the explosion was deafening—and devastating. As the smoke cleared, Jinda could see that at least five students were sprawled motionless on the ground.

There was no curbing the panic that swept through the crowd after that. Screaming, flailing at one another, people tried to claw their way out of the square.

A few students, some of whom Jinda recognized as Kamol's friends, drew their pistols and brandished them, then fired wildly into the air. It was to avoid this kind of response, Jinda suddenly realized, that Ned had insisted on Kamol's remaining at the headquarters that morning.

"No!" Ned was shouting at the students now. "Stop! Don't shoot back!"

But they ignored Ned and continued to shoot in the air. Then Jinda heard a sharp staccato rattle in the distance. She saw students dropping to their knees in crumpled heaps. The soldiers were firing into the crowd.

"Dear Lord," Ned whispered. "It's happening."

"Ned! What's going on?" Jinda clutched at his hand.

He looked at her, his eyes dazed. "It's no use, Jinda. It's over. You've got to get away. Run, quick! Along the river." He pushed her off the platform, and she landed clumsily on the grass below. "Run, Jinda!" he shouted.

[Jinda's father, Inthorn, dies in prison and is buried at home in the village. Jinda returns in time for the funeral and grieves to see him so gaunt and haggard, but a scene from her childhood comes back to her.]

And then she remembered.

His hand is big and bony, just at her eye level. His thumb is just the right size for holding onto. His fingernails are stained a reddish-brown from working in the soil, and there are hard calluses on his palm. She clings to his thumb as they cross the fields. Running along the narrow dikes, she takes two steps for every one of his, holding on to his hand for balance.

He walks fast, but steadily. He never falls. The rice stalks bow on either side of her as a breeze sifts through. Their heads of grain droop above her head. Rows and rows of brown stalks, stretching endlessly away.

"Why are they all brown?" she asks breathlessly.

"What?" His voice is dreamy, remote, far above her head.

"The stalks. Why do they turn brown? Why can't they stay fresh and green?"

"Nothing stays fresh and young forever," he says quietly. "When the stalks are young, they're green and strong. But when the rice grains form, the stalks send up all their strength to the grain, and get tired, and turn brown."

"Poor stalks," she says. "I want them to stay green."

He laughs, and his laughter stirs her like a cool breeze, making the back of her neck tingle. "But if they do, the seeds won't form, little one. And without any seeds, there won't be another rice crop the next year. The stalks have to die so that new stalks can grow after them."

"Why?"

"That is how life goes on. The old must give up their strength so the new can grow."

"Why?"

"That is just the way things are."

"But why?"

"Why, why, why!" He laughs and lifts her up, tossing her into the air. For one heart-stopping moment she is sailing above the brown fields, flying toward her father's strong, waiting arms. "Why? Because Father loves you, that's why!"

Because I love you, she echoes and laughs too.

The tears streamed down Jinda's cheeks now, merging with the rain. She wept hard, but she was laughing, too, and it was a relief to laugh and cry at the same time. Hugging the bodhi tree, her body shook so hard she had to hold on to the great tree for support.

Of course he hadn't died for an idea. Ned was wrong. Her father hadn't died for justice, or equality, or democracy. Like the strong green rice stalks that shrivel as the grain ripens, her father had given up his life for his children, so that they might grow stronger. And he had done it out of love.

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RICE IN INDONESIA

"The Story of Rice" and Hindu Beliefs

As an archipelago of more than 13,600 islands, Indonesia is a country of immense diversity. Although each island has its own history, traditions, and customs, the religions followed are one of the most important things that people from different islands share. Although most Indonesians are Muslim, there are also groups who follow Buddhism, Hinduism, Christianity, and groups who maintain their traditional rituals and beliefs often referred to as "animism," or the belief that nature is alive and imbued with spirits.

Religious stories are important means of passing on values and lessons to followers. "The Story of Rice" has its origins in Hindu beliefs and tells about the beginnings of rice cultivation by earth-bound humans.

Read "The Story of Rice." With your group, discuss the following questions:

1. How is the cultural importance of rice illustrated in this story?
2. Refer to a textbook, encyclopedia, or other reference book on Hinduism. What are some of the basic beliefs of Hinduism?
3. What are some of the important religious themes or values in this story?

Group Task

Using a shoebox and other materials, create a diorama or scenic representation illustrative of a scene from this story. Make sure you incorporate the importance of rice as described in the story. Prepare to describe your diorama to the rest of the class.

activity #3

THE STORY OF RICE[1]

Once Batara Guru, the Lord of the Gods, was building himself a new palace, and he sent word to all the gods in heaven that each must bring a big stone for the foundation of the palace. Everyone promised to obey the command except the Snake God. When the Messenger God came to him, the Snake God shook his head sadly and said: "As you can see, I have neither arms nor legs. How could I carry a stone?" As he spoke, three large teardrops rolled down his cheek. When the teardrops fell to the ground, they turned into three white eggs. "Take those eggs to the Lord of Gods and tell him exactly what happened," the Messenger God told the Snake God.

So the Snake God set off for the royal palace holding the three eggs carefully in his mouth. On his way he met the Great Eagle. "Where are you going, Snake God?" asked the Great Eagle. But the Snake God's mouth was so full of eggs that he could not answer. The Great Eagle repeated his question twice more and, getting no answer, became very angry. He started pecking the Snake God on the head. This hurt so much that the Snake God gave two loud cries, and each time he opened his mouth one of the eggs fell out.

As the eggs hit the ground, they broke open and out of each came a piglet. The two piglets were adopted by a cow and raised together with her own calf. The calf's name was Lembu Gumarang, and as we shall see, he grew up to be an evil bull with magical powers, a great enemy of both gods and men.

The Snake God was sorry he had lost the two eggs, but by good luck one still remained safe in his mouth. He brought this last egg to the Lord of the Gods and told him what had happened. The Lord of Gods ordered him to keep the egg until it hatched and then to bring him whatever came out of it.

The Snake God carried the egg home and took very good care of it. Finally, at the end of the month, the egg broke open and out of it came a beautiful baby girl. The Snake God hurried to take the baby to the Lord of Gods, who adopted the baby as his own daughter and named her Dewi Sri. She was brought up as a princess in the royal palace with all the loving care that a daughter of the Lord of Gods should have.

As the years passed, Dewi Sri grew up to be a lovely young lady. She was as gentle and kindhearted as she was beautiful, and everyone who knew her loved her. The Lord of Gods himself showed her so much affection that the other gods began to fear he might want to marry her. The law said that no father could marry his daughter, not even if he was a god and she was only his adopted daughter. The gods feared that if this law was broken, the whole kingdom would be ruined. So they met secretly

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[1] from Asian Cultural Centre for UNESCO, *Folk Tales from Asia: For Children Everywhere*, New York: Weatherhill/Heibonsha, 1975.

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and decided that Dewi Sri must be killed. This decision filled them with sadness, but they thought this was the only way to save the kingdom.

So the gods put poison in a piece of Dewi Sri's favorite fruit and gave it to her. No sooner had she eaten the fruit than she fell sick. Day by day she grew weaker and weaker, and finally she died. It was just as though the slender stalk of a young flower had gradually wilted and fallen to the ground. Dewi Sri's body was buried with royal ceremony, just beside a beautiful triple-roofed pagoda, and a royal servant was left to guard the grave and to water it daily so that flowers would grow around it.

Presently from the grave there appeared a strange kind of plant that no one had ever seen before. This was the heavenly plant now called rice. Rapidly it grew tall and put out many ears, which in time turned yellow and produced many grains of rice.

When the Lord of Gods saw this miracle, he told the royal servant to take the rice seeds down to earth and give them to the king of the land called Pajajaran. "Tell the king," he said, "that the seeds are a gift from me. Let his people plant them and take good care of them, and then no one need ever go hungry again, for rice is the food of life."

The king of Pajajaran was very happy to receive this wonderful gift from heaven. He distributed the rice among his people. The royal servant from heaven taught the people how to sow the seed both in paddy fields and on hillside terraces, how to harvest the plants, and how to thresh the rice. Then a goddess from heaven came down to earth and taught all the young girls how to cook the rice and serve it in many delicious ways. After that time the people in Pajajaran never lacked food. For many years they lived in peace and happiness.

But one day a wicked merchant from another land came to Pajajaran to trade. Seeing and tasting the wonderful rice, he wanted to buy it all and take it away, but the king refused, saying: "This rice doesn't really belong to us but to heaven, for it came from the grave of the heavenly Dewi Sri. So we cannot sell it to you." This made the merchant very angry. He went to the cave of the calf Lembu Gumarang, now grown into an evil bull with magical powers, and asked him to destroy all the rice in Pajajaran.

The bull set to work at once. He blew up a great wind that crushed all the growing rice plants to the ground. Seeing this, the Lord of Gods sent a young god named Sulanjana to save the rice. Sulanjana blew away the wind and lifted the young plants upright again.

Then the evil bull called his foster brothers to help him destroy the rice. These were the two piglets, now grown to be huge, fierce hogs. There was a terrible fight between the animals and the god Sulanjana. The animals called up hundreds of wild pigs to trample the rice, but the god filled the land with such heavy fog that all the pigs lost their way. Then they sent thousands of rats to nibble the rice plants, but the god set poison in their tracks so that all the rats fell dead. Again the wicked brothers called

millions of birds to peck the ears of the rice, but the god frightened the birds away with his magic spells.

At last the evil bull called all the wild beasts in the forest and told them to destroy all the towns and villages of the country. Then all the people, even the young children, came to fight beside the god. Under his leadership they dug holes and set traps in them and they fastened nets to the treetops.

Suddenly the army of wild beasts, led by the bull, came rushing from the forests, crashing through the trees. But many of them fell into the traps and many more were caught in the nets. The bull saw that his army was losing, but still he would not surrender. "Sulanjana," he called to the god, "don't think I've lost yet. I dare you to come fight with me and see who is stronger."

The young god stepped out bravely to meet the challenge. He stood with his hands on his hips, waiting for the bull to charge. The bull sharpened his horns against a tree trunk and then came rushing at Sulanjana with all his terrible force. But the young god jumped aside at the last minute; and as the bull went charging by, the god stuck out one foot and tripped the bull so that he came crashing to the ground. Quickly the bull rose to his feet and charged again, only to be tripped once more. Again and again the bull charged, but each time Sulanjana was too quick for him.

At last the god grabbed one of the bull's feet and swung the animal round and round in the air. Finally the bull could not stand it anymore. He cried out for mercy, and the god agreed to spare his life if he and the two evil hogs would promise to guard the rice fields forever after.

The animals promised and the people of Pajajaran cheered. From that time on the rice fields have been loyally guarded by the animals, and the fields have never been disturbed again. And ever since that time the people of Pajajaran have lived in peace and happiness, enjoying the delicious rice that is the food of life.

Retold and translated by Ati K. Kartahadimadja.

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RICE IN JAPAN

Kamishibai: A Traditional Form of Japanese Storytelling

Kamishibai (literally, *paper stage*) is a traditional Japanese form of storytelling in which a speaker tells a story using pictures. The people of downtown Tokyo created this unique form of storytelling in a time of economic hardship. *Kamishibai* has spread throughout Japan, East Asian countries, and the United States as an entertainment for children and an educational tool. In the *kamishibai*, approximately 10 to 20 drawings are placed in a frame, and each drawing is pulled out and replaced by a new one as the story progresses through the narration. Because an individual drawing has no movement, the observers use their own imagination to create the story, connecting the pictures and the narration in their minds. Storytellers use voice fluctuation and change scenes with varying speeds in order to make the story come alive.

Mochi

In the story, "The Old Man Who Made Dead Trees Bloom," the kind old man and his wife put steamed rice in a mortar and pound it to make *mochi*. *Mochi* is a rice cake that is eaten on New Year's and other times throughout the year when people need strength. It is thought to be a source of power and energy.

In addition, rice itself is seen as a symbol for the "good life." In countless folktales, characters receiving wealth from rice live happily ever after.

Read the following Japanese folktale, "The Old Man Who Made Dead Trees Bloom." As you read through the story, ask yourself the following questions:

1. How does this story illustrate the symbolic meaning of rice in Japanese culture?
2. What kind of values does the story teach?

Group Task

Your task is to create your own *kamishibai* based on this story. The *kamishibai* should consist of at least six different drawings illustrating specific scenes from the story. You will also write the narration for each of the scenes. The combination of the narratives should cover the events of the entire story. As you are deciding what to include in your drawings, remember to consider the symbolically important role that rice plays, as well as the contrasting values illustrated in the two old couples.

activity #4

THE OLD MAN WHO MADE DEAD TREES BLOOM[1]

Long, long ago, there lived an old man and woman who were honest and kindhearted. But next door to them lived a wicked and greedy old couple.

The good old man had made a pet of a dog. One day, the dog led him to a patch of garden at the back of his house and barked earnestly as if to say: "Dig here! Dig here!" Realizing what the dog meant, the old man immediately dug the ground with a spade. To his great surprise, he found a lot of *oban* and *koban* (large and small gold coins of feudal Japan) and precious stones.

The old man brought the discovered treasure into his home. As he and his wife were examining and counting the find, the greedy old man next door happened to drop in. Astonished at the mountain of gold coins and precious stones, he asked the good old man what had happened. Told about his neighbor's good luck, he borrowed the dog and took it to a garden behind his own house.

The greedy old man dug the spot where the dog barked. But far from finding gold coins, he was shocked to see a host of loathsome creatures—snakes, lizards, frogs, centipedes, etc.—creep out from under the ground. Deeply disappointed and infuriated, he killed the dog, buried it in the garden and stuck in a willow tree twig to mark the spot.

As the dog did not return for hours, the good old man became worried. He went to the wicked neighbor and heard what he had done to the poor dog.

The next day, he went to the spot where the dog was interred, in order to console its spirit. But he was amazed to find the willow twig had grown overnight into a giant tree about two arm lengths around. The good old man felled the tree and made a mortar out of its trunk. When he and his wife put steamed rice in the mortar and pounded it to make *mochi* (rice cake), a large number of *oban* and *koban* gold coins came pouring out of the mortar to their great surprise.

It so happened that the greedy old neighbor was peeping in at the time. He asked to borrow the mortar and took it back home. When he started to pound rice in the mortar with his wife, one filthy thing after another came out, such as discarded old roof tiles and broken utensils—but never the gold coins he wished to get! Incensed, the greedy man burned the mortar in his kitchen range.

When the good old man came to get back the mortar, it had already been reduced to ashes.

Resigned to his loss, he accepted instead part of the ashes. On his way home, a small amount of the ashes spilled from the palm of his hand, falling onto withered grass. At that instant, the grass flowered into fresh green! Heartened, the good old man climbed up a tree in his garden as

[1] from The Japan Times. *Folk Tales of Old Japan*, Tokyo: The Japan Times, Ltd., 1975.

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soon as he returned home and sprinkled the ashes all around. Instantly, all trees in the vicinity—even dead ones—put forth beautiful flowers as if the floral season of spring had come round ahead of time. Impressed with the good old man's magical performance, all the people in the neighborhood applauded him and called him *Hana-saka-jijii* (Old Man Who Makes Trees Flower).

His jealousy aroused by this, the greedy old man took out the remaining ashes from the kitchen range and climbed a tree in his garden to emulate the feat of his neighbor. Many people in the neighborhood gathered around to wait for dead trees to flower. However, the ashes scattered by him, far from making dead trees blossom, were merely blown about by a gust of wind, smarting the eyes of the watching crowd. The enraged spectators punished him roundly.

activity #5

RICE IN THE PHILIPPINES

A Legend from the Philippines

Often referred to as the eighth natural wonder of the world, the rice terraces of the Ifugao Province in the Philippines have stood as monuments to the ingenuity and resourcefulness of the Ifugao people for over 3,000 years. The terraces rise as high as 4,500 feet across the rugged Cordillera mountain ranges in beautiful and intricate patterns. From end to end, they add up to some 14,000 miles—more than halfway around the world. The descendents of these ancient architects, the Igorots, are still living among the terraces growing rice in much the same way as their ancestors did.

As in many other cultures, folktales play an important role in passing down the values, beliefs, and understanding of the world held by Filipino people. Although these folktales may be very old and explain things we now understand better, they remain a vital part of the cultural life and continue to teach about both the past and the present.

Read the story, "The Star Women: Or, An Igorot Legend of the Rainbow." As a group, discuss the following questions:

1. How is rice and rice production important in the story and in the lives of the people living in Ifugao today?
2. What kinds of values does this folktale teach?
3. How do the Igorot view the natural world and their place in it?

Group Task

Your task as a group is to imagine you are farmers in the rice terraces of Ifugao and to create and perform a 5-10 minute skit or dramatic piece modeled on the "Igorot Legend of the Rainbow." Be sure to consider what values you want to encourage in your community and your children, what role rice plays in your life, and what your concerns for the present and the future might be. Be prepared to share your skit with the rest of the class.

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THE STAR WOMEN: OR, AN IGOROT LEGEND OF THE RAINBOW[1]

This is a very old story from the northern mountains of the Philippine Islands. There, a long time ago, a tribe called the Igorots learned to plant rice by building terraces on the steep mountainsides. If laid end to end, people say these terraces would encircle the globe.

Once there was a man who farmed one of these terraces. His name was Laki. When the planting season came around, Laki woke before it was light and went straight to his land. It was hard planting rice: he had to stoop and stoop, and the sun burned the skin right off his nose and forehead. There were weeds he had to pull. There were parts of the terrace that had fallen down and he had to find new stones to fix them. Laki worked from morning until night. When he went home to his little hut farther down the mountain, he always looked up at the stars. Up in the clear cold mountain air, they appeared much brighter than they did in the lowlands. He liked walking home to his hut guided by starlight.

One day in the middle of the planting season, Laki went back to his terrace and found that all the stones that shored up his terrace had fallen down. Since he was a patient man, he did not waste any time cursing his bad luck. He quickly set to work, but it was a whole day before he fixed the last stone in place and headed home.

The next day, when Laki returned to his field, once again all the stones lay scattered about the field. This time Laki could not help feeling angry, and also a little afraid.

"Who could have done this?" he asked himself. He decided that he would stay in his field all night and try to catch whoever might be destroying his work.

Again he worked hard to gather the stones and fix the terrace walls. But this time, when the moon rose high, he remained behind a rock, waiting.

He waited a very long time. A cold wind blew across the mountaintops and chilled him until his teeth chattered. He heard the rustle of bats' wings in the darkness. He heard the slither of snakes along the dry stone of the terrace walls. Finally, his back began to ache from lying so long on the hard ground. As he got up to stretch, he glanced up at the sky and saw something that made him blink and sit upright. The stars were moving! They were coming closer and closer to the earth! Three of them in particular seemed brighter than the others.

Laki waited and watched. Soon he could see the stars move to a spot almost directly above his head, then fall straight into his field.

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[1] adapted by Marianne Villanueva, from Eugenio, Damiana, ed. *Philippine Folk Literature.* Philippines: University of the Philippines Folklorists, Inc., 1989.

Laki closed his eyes. After a while, when he opened them again, he had to rub them to make sure he was not dreaming. Up close he saw that the three stars were beautiful, pale women with delicate wings attached to their shoulders. They moved about lightly on slippered feet. Their wings fluttered gently whenever the star women moved, and glowed with a strange light.

Now Laki saw that the women were busy removing each other's wings. They laid them down carefully on the ground. Then they laughed and clapped their hands, and at each clap stones fell from the terrace walls.

"Oho!" thought Laki. "So that is how you have your fun!"

While the women were playing and laughing, Laki crept forward and took a pair of wings from the pile the women had left on the ground. Then he gave an angry shout. Startled, two of the women grabbed their wings and flew away. The youngest of the three was the one who was left behind. When she saw Laki, she angrily stamped her slippered feet. Laki saw that she was very beautiful, and right then and there, he fell in love with her.

Laki took the woman by the hand and said, "Don't be afraid. I will not harm you. But in exchange for all the trouble you have caused me, you must help me in my home."

Laki took the star woman to his house and showed her all the work that the earth people do. He explained to her about cooking and washing and cleaning. At first the woman told Laki she could not bear the odor of the earth, the odor of mud and sweat and living things. She said she found it difficult to breathe with this odor constantly clogging her nostrils.

But Laki was very kind, and planted flowers around his hut so that their fragrance filtered out all the other smells. After a while, the star woman stopped weeping and talking about her home in the heavens. She helped him in the fields. She cooked for him in the evenings. She even grew a little vegetable garden by their hut. In time, Laki and the woman were the joyful parents of a handsome baby boy.

The boy was very beautiful, with pale skin and light-colored eyes and hair. After he was born, Laki and the star woman and their son lived happily together as a family for three years.

As time passed, Laki grew careless. One day, he sent the woman to the granary to fetch some rice. She happened to see the tip of one of her wings, peeping out from under a corner of the eaves. Laki had hidden them there many years ago and forgotten all about them. Without hesitation, the woman took them and called to her son. When the boy came running, the woman swept him up in her arms and flew up with him to the heavens.

After a while, when the woman did not return, Laki went to look for her. In the granary, he found one of his son's tiny slippers, and he looked under the eaves for the pair of wings he had hidden there. When he saw that they were gone, he wept and cursed his carelessness. He lost all interest in his field and sat all day in his hut, letting his hair grow. Finally the

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sound of his weeping began to bother the great god Lumawig. Lumawig parted the heavens and looked down on earth to see whose weeping was disturbing his rest. He saw Laki, crouched in front of his hut. By this time, Laki had become so thin his ribs stuck out, and his hair was long and scraggly.

Lumawig asked Laki to explain what was troubling him. "It was my fate to fall in love with a star woman," Laki said. "And now she has taken our son and gone back to the heavens, and I will never see them again."

Upon hearing this, Lumawig was moved. He decided then and there that he would help Laki. So Lumawig told Laki that he would let down a rope from the sky.

"Climb this rope," Lumawig told Laki, "and you will come to a land above the clouds. There to greet you will be eight beautiful maidens, all looking exactly alike. One of these will be your wife. Choose the wrong maiden, however, and you will instantly find yourself back on earth, and you can never hope to see your wife again."

So Lumawig let down the rope, and Laki climbed it. He came to the land above the clouds, and there were the eight beautiful maidens, waiting to greet him.

Laki looked them all in the eye, but could not decide which one was his wife. But just as he was turning away, he thought he saw a trace of wetness on one of the maidens' cheeks. Immediately, he grabbed the maiden by the hand.

"This is my wife!" he exclaimed. And it was.

She hugged him, because it turned out that she had missed him. But when Laki tried to convince her to come down to earth with him, she shook her head sadly.

"I cannot live there," she said. "My home is here, in the heavens."

At this point, Lumawig decided to intervene.

"I will make a road," said Lumawig, "stretching from heaven to earth, so that you can visit each other from time to time. That way, you can each live in your own worlds, but you will never be apart."

So Lumawig built the road, and it was a splendid road of many colors. It curved from the heavens to the earth, but it was invisible. One could only see it after it had rained, and after a long time people began to refer to this road as the "rainbow."

activity #6

RICE IN BANGLADESH

The Role of Women in Rice Production

In Bangladesh, approximately 60 to 80 percent of the rice produced is consumed in the home. The remainder of the rice is traded for money or other needs. Although women do not cultivate rice, they play several important roles in the course of rice production. According to the study *The Hard Working Poor* by A. Farouk and M. Ali, women work more hours at productive work than men. According to this study, the workday of rural women begins at 4:30 or 5:30 A.M. and ends at 8 or 9 P.M.

Some of the specific tasks of the women include testing the quality of the stored seeds before the men take them to the fields to plant. Also, although women do not go out to the fields themselves, they have an extensive knowledge of rice growing, and when they are widowed, they also often supervise laborers. It is the job of the women to feed the laborers two or three meals a day. Women also have the responsibility of caring for the bullocks: feeding them, cleaning their sheds, and watching out for their health. During harvest time, the workload of the women significantly increases, as they control the process in which the paddy is converted to edible rice. Women make countless decisions that affect both the quantity and quality of the processed rice.

(From a study prepared for the International Labour Office, by Tahrunnessa A. Abdullah and Sondra A. Zeidenstein)

Read the following firsthand account of Rahima Khatun, a woman from Bangladesh, talking about her role in the family. As you read the passage, ask yourself the following questions:

1. How is this woman's work perceived by others?
2. What are the emotional /psychological factors connected to the work she does? Does her work seem to be appreciated?
3. How does she describe the cultural importance of rice in Bangladesh?
4. One U.S. dollar is currently (as of May 1995) worth approximately 40 taka (Bangladesh currency). How much has the value of one maund of rice changed from when this article was written?

In addition, read the lyrics to "Song" written by singer/composer, Abdul Latif, from Bangladesh, and the poem, "Ripple of Paddy in the Breeze" written by the eminent poet, Jibanananda Das, who was born in Bangladesh but lived in Calcutta. Consider the life of women in relation to rice culture in Bangladesh. The song was written about 30–40 years ago, and the poem was written about 40 years ago.

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Group Task

Your task is to compose a poem based on the various situations and feelings depicted by Rahima Khatun's experience. The poem should not simply recount the woman's physical tasks, but instead give a sense of her internal feelings as she does her work. Write your poem on a sheet of newsprint and prepare to share it with the rest of the class.

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activity #6

REFLECTIONS OF RAHIMA KHATUN[1]

It is the second week of June, the first month of Bangladesh's rainy season, and the air is sweet with the smell of jackfruit. For Rahima Khatun it is a quiet period. The work frenzy that accompanies the harvesting of the family's rice or jute is still several months away.

"Rice has been cultivated since the creation of humanity," she says. "Our elders say it used to be easier to grow in the olden days because you didn't need fertilizers and you didn't get sores from chemicals if you walked through the wet rice fields. All you had to do was plant the seeds."

"Even though women do not cultivate the rice," she goes on, "there is always a lot to do. Men don't appreciate the work that women do."

"Sometimes my husband asks me what I do all day. And if he asks me to do something extra I'll have to do that too. At this time of year I can sit and talk, but I couldn't if it was harvesting time."

During harvest, her father-in-law and her husband cut the rice. But everything that happens thereafter is the responsibility of women: preparing the earth for threshing by covering it with mud and cow dung; hand winnowing; parboiling, steeping and drying the rice for storage and then milling to remove the husk. And they are responsible for safe storage, especially for seed stock.

"Today I protested, and said if my husband didn't get the rice husked in the large mill in Kamalpur I wouldn't cook. It is expensive to go to the mill of course, and you have to think of saving costs, but I am just one person, so I can only do so much with the *dheki* (hand mill). If there are two people, it doesn't take so long to husk rice—if you start at six in the morning you can finish a fair portion by nine.

"After that it doesn't take long to cook. We eat rice and *dal* and whatever vegetables we have—eggplants and cabbage. This year, though, we have grown very little in the yard, and we will need to buy some vegetables. The men were angry about that."

"We usually also sell some rice. At the moment it fetches 250 taka (approximately seven dollars) per maund (about 40 kilos), and it will go up to 320 taka (approximately nine dollars) per maund by November or December. If we wait for a month or so, the price will go up by another 10 or 20 taka. Of course the traders make a profit; we make a profit; that is how we all live.

"There are many types of rice, almost as many names as there are names of people. We grow mainly Irri, a high-yielding hybrid, local varieties such as Paijam, Aush, and Aman.

"Rice is everything—whether we sell it or save it. From rice powder we make cakes, puffed rice, flattened rice, semolina. Rice water is used for starching clothes and feeding cattle. If anyone is sick then we sell rice for ready cash to buy medicines.

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[1] from 1994 Calendar. Washington, D.C.: New Internationalists Publications, 1994.

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"You feed each person as is appropriate. Obviously my father-in-law gets most, then my husband, and then my daughter because she is the youngest. It doesn't matter if there is none left for me—although my husband and father-in-law keep me some and see that I have enough. It is difficult to get by," she says, "if there is no love in the family."

"SONG"[2]

by Abdul Latif
(translated into English)

I am a girl, live in the village
It is my hobby to wear rice stalk as a necklace
The peasants harvest paddy around the fields
I fill out the empty bowls with it
I make the flattened rice, puffed rice
And other cuisines out of the new paddy
I move around with sarees and ornaments trading rice for money
And of course, whenever I am hungry I take rice at heart's content

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"RIPPLE OF PADDY IN THE BREEZE"[3]

by Jibanananda Das
(translated into English)

I have heard the ripple of paddy in the breeze—
dripping slowly in the afternoon
I have seen the color of golden sunshine—
that is like the first love of the body
Pineapple groves have covered the beauty
with its sprawling hairs
One day this body had risen in this Bengal from the grass,
from the flavor of the paddy
The body had known beauty from the faces of Bengali women,
walked in the ways of Bengal
like the free seagull and blackbird
The body which is like the spurting grass
was washed by the water of Bengal

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[2] The translation of this widely-known song was kindly provided by Mayu Hagiwara, Embassy of Japan in Bangladesh.

[3] The translation of this widely-known poem was kindly provided by Mayu Hagiwara, Embassy of Japan in Bangladesh.

Lesson 3

POPULATION GROWTH AND RICE

Organizing Questions

- What is the impact of population growth on rice production now and in the future?
- What is the influence of this growth on the use and distribution of the resources we depend on to live?
- What does this mean for the way we approach actions in the present and in the future?

Introduction

> Anyone who examines the world's annual output of basic grains—rice, wheat, corn, and other coarse grains—and compares it with the world's total population will make a startling discovery. If the grain is converted into calories and protein available on a daily per capita basis, the total is significantly greater than the amount of nutrients needed for human survival. Further, over the past three decades the world has produced more grain per capita, not less. And yet in any given year of that recent history several million people have died from hunger-related causes. On any given day perhaps a billion individuals are restricted by their economic circumstances to consume less food than they would like, and hundreds of millions have their growth and physical activity limited by inadequate food consumption. (Scott Pearson, Walter Falcon, and Peter Timmer, "Introduction to Food Policy Analysis," in *Food Policy Analysis*, p. 3.)

Thousands of years ago, the number of human beings on earth was small enough that our actions made little difference on the planet and there was enough food for all to eat (assuming it could be found or caught). The human population has grown rapidly ever since, and many claim that there are scarcities in the land and resources needed to produce enough food to feed everyone. The existence of hunger in the world is undeniable; we are faced with a future of even more people and even more hunger. What does this mean? How will this growth influence rice production in Asia and the Pacific? How will it impact the natural resources upon which rice production is based?

This lesson is divided into two parts that enable students to explore the concepts and connections between population growth and resource use in rice production in small learning groups focused on the six countries introduced in the prior lessons. Part I looks at

the meaning of population growth over time and the notion of exponential growth and population density through an exercise using popcorn. Part II examines the notion that we are living in a world of limited resources and presents us with questions about the implications for the future.

Objectives

knowledge

- to recognize the magnitude and rate of population growth in six countries of Asia and the Pacific
- to understand the Malthus Hypothesis and consider how it does or does not apply to population growth and rice production in Asia and the Pacific
- to understand Boserup's theory of population growth
- to consider the impact of increasing population growth on rice production and the ability to produce enough rice now and in the future
- to recognize the role of unequal distribution and consumption in the relationship between population growth and rice production

attitude

- to recognize population growth as a controversial but critical issue in rice production
- to gain respect for the complexity of population issues, their cultural aspects, and the need to approach them with sensitivity and understanding

skill

- to work in small groups to make decisions
- to make educated guesses about the future based on past and present trends
- to manipulate and understand statistics that relate to population growth and rice production in Asia and the Pacific
- to think critically about the impact of population growth on rice production and food availability in the past, present, and future

Materials for Part I

- 21 empty dozen egg cartons (see Procedures for Part I below for cutting and distributing sections)
- two cups unpopped popcorn kernels
- fifteen cups popped popcorn
- World Population Projections, 1750–2150, transparency
- Country Information Sheets #1–6

Materials for Part II

- one package of crackers (13 crackers)
- 117 cookies (same size as crackers)
- Event Cards
- Country Circle Diagrams

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Procedure, Part I

1. Cut and distribute the egg carton sections as follows:

Bangladesh
3 sets of 1-section egg carton pieces

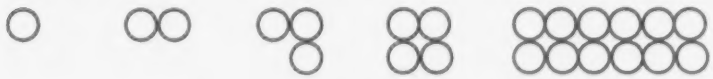
China
6 sets of 12-section egg carton pieces

Indonesia
3 sets of 4-section egg carton pieces

Japan
3 sets of 3-section egg carton pieces

Philippines
3 sets of 2-section egg carton pieces

Thailand
3 sets of 4-section egg carton pieces



1-cup egg carton section | 2-cup egg carton section | 3-cup egg carton section | 4-cup egg carton section | 12-cup egg carton section

2. Begin this lesson by showing the World Population Projections, 1750–2150 transparency. Share the following information with the class:

   By the year 2050, there will be about 10 billion people in the world, about half of them in Asia. About 5 billion of these people will be rice consumers. By current estimates, the world's rice production must rise by 70 percent. To make this happen, 870 million tons of unmilled rice will be needed each year, and the rice must be grown with less water, less labor, less crop losses, less pollution, and on much less land than today. At the present, the daily existence of more than 2 billion people depends on rice, and the world is not prepared for the challenge of feeding a hungry world in the next half-century.

   At the present, the global population is about 5.6 billion. There are approximately 140 million births per year and about 50 million deaths per year. 140 million births per year calculates to roughly 16,000 births per hour, and 50 million deaths per year calculates to roughly 6,000 per hour. The net increase in population per year is about 90 million per year (about the size of Mexico's population), and the net increase in population per hour is about 10,000 per hour. Present the following problem to the class:

   During a normal school day, by how much does the world population increase?

3. Explain that the next activity will explore population growth in six countries in Asia by using popcorn. Tell students that it is often easier to understand the meaning of numbers and statistics when we can see them represented. Stress that it is important to pay close attention to the numbers and directions for the next activity because they guide the action and determine the outcomes. The activity will proceed in three

rounds during which the population of the six countries will be growing, as represented by the popcorn.

4. Distribute the Country Information Sheets, one to each of the six groups. Pass out the appropriate egg carton sections and ask each group to read the Information Sheets and label the egg cartons according to the directions.

5. Announce the beginning of Round 1. As directed, the students in each group must figure out how many unpopped kernels of corn they need. Note that one unpopped kernel of corn represents 5 million people. Make sure each group begins with the correct number of kernels. Students should place an equal amount of popcorn in each egg carton section for best visual representation. Announce the end of Round 1 when all the groups have placed their unpopped kernels in the egg cartons marked "1980."

6. Announce the passing of 15 years and the beginning of Round 2. As explained in the Country Information Sheets, each group should take the number of popped kernels that represents its country's increased population after the time elapsed. Explain that the same number of kernels popped is twice as many people; one popped kernel of corn represents 10 million people. Make sure each group understands the relationship between popped and unpopped corn (see the table below to check for the correct amounts of popcorn). After conferring with one another to be sure the numbers are right, the students then place these popped kernels in the second set of egg carton sections marked "1995." This provides a comparison between the original population density and the present population density based on the same area of land (i.e., the same number of egg carton sections).

7. Announce the passing of 55 years and the beginning of Round 3. Again, students from each group place a number of popped kernels equivalent to the increased population size into the third set of egg carton sections, labeled "2050." This provides a third point of comparison for the idea of population growth, the rapidity of that growth over time, and the limited resources we have to deal with this expansion (land, for example). If you want to check to make sure students have done the exercise correctly, the following table lists the amount of popcorn that should be in each egg carton for each country:

Year	Bangladesh	China	Indonesia
1980	18 unpopped	90 unpopped	30 unpopped
1995	11 popped	60 popped	18 popped
2050	17 popped	80 popped	24 popped

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Year	Japan	Philippines	Thailand
1980	24 unpopped	10 unpopped	10 unpopped
1995	12 popped	6 popped	6 popped
2050	12 popped	9 popped	7 popped

Discussion

1. Debrief the activity by asking students to compare their three sets of egg carton sections and the process of filling them. Was it surprising how quickly the popcorn grew and how much space it took up? Did the task of fitting the popcorn into the sections become more difficult with time? Ask the different groups to share their results so that the students can compare the situations of the various countries. Which country had the most difficulty fitting their popcorn into their containers? Which had the easiest? Why was that the case? (Possible answers may include slower population growth, larger container, or fewer original kernels).

2. Help students to make connections between the manipulatives in the activity and actual population growth in the various countries. What did the popcorn represent? What did the containers represent? (People and land, respectively). How is the activity similar to actual population growth? (The number of people is increasing while the amount of land stays the same). Explain that the population density of a country is the amount of people per unit of space. Compare the population density numbers on each of the Country Information Sheets and the number of popcorn kernels per egg carton section to understand the differences between different countries.

   Which country has the most people per square mile (in other words, which country has the most popcorn per egg carton section)? Make sure students understand that most of the numbers they worked with in the activity were actual population statistics for the past, present, and predictions for the future based on current rates of population growth.

3. What are the possible implications of this rapid increase in population for the people themselves, for the food available, and for rice production? For example, higher population density may mean more poor people, the need for more food, and the necessity of finding ways to increase the rice production despite an inability to increase the amount of land available for growing rice. What are the implications for finding jobs and housing for this increase in population, and how will this lead to further competition for resources?

4. Explore some of the possible reasons that the population is growing instead of staying the same. Birth rate exceeding death rate is one primary reason. This is a result of high fertility rates

as well as better health, resulting in longer lives. Suggest that fertility rates can often be depressed by the postponement of marriage and births. There are grounds for optimism because in recent years fertility decline has been occurring in many developing countries.

5. Ask students to brainstorm some of the reasons people in these six countries might have more than three or four children. Include considerations of high infant mortality due to poor health conditions, lack of birth control, status of women, farm labor, old age care, economic earnings in urban areas, size of living accommodations, and cultural/religious beliefs and traditions. Encourage students to consider the reasons for having children in their country. Ask students how many children there are in their own families.
6. Can other events or factors change the population growth patterns in a country? (Consider wars; natural disasters such as drought or floods; changes in poverty, distribution, or cultural attitudes; better use of land; immigration, etc.)
7. Explain that everyone does not agree on the impact of population on the future. The population numbers used for the future are predicted using the rates we know today, but as discussed above, much can intervene to change those predictions and their implications for the world. What are some of the implications of this growth for rice production? The next activity will explore different ideas of what the future will hold as it relates to population growth and rice production.

Procedure Part II

1. Begin this lesson by having the students reflect on what they learned from the previous activity. Students should understand that population densities in Asia's rice producing countries are among the highest in the world, and due to population growth, continue to increase at a striking rate. This activity will explore how rapid population growth puts increasing pressure on the already strained food-producing resources of a country.
2. Recall that in the previous exercise, people in different countries in Asia and the Pacific were represented by popcorn. In this activity, the students themselves will represent the people of the six countries. This exercise uses the same structure as the previous activity, insofar as students participate in three rounds of this activity in one of six small groups representing a country in Asia or the Pacific.

   Throughout the activity the students will be given cookies, which represent the rice consumed by the people of these countries, and crackers, which represent other food available to the population that is less desirable, like millet or less desirable

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types of rice. The two food types will be referred to as "rice" and "millet." (Other foods may be used to represent these two food types. However, they must be the same size and the "rice" should be better tasting and more appealing than the "millet.") Students should understand that rice and millet are of equal nutritional value (1 millet = 1 rice in nutritional value) and that countries are often forced to increase millet production because it is less expensive to produce than rice.

Explain that during the three rounds of this activity, each student remains as one person in an increasing population, and each individual's share of food thus changes as time goes by. Inequality in the countries will be apparent throughout this exercise as the food supply dwindles. Tell students that the minimum nutritional requirement for each person to keep from going hungry is one unit of food (one cookie or one cracker, for example); beyond this requirement, the people in the group should save their additional food supply.

The teacher should use the country circle graphs included on pages 95-100 to fully understand the distribution of food and to visualize student involvement in the various rounds of this activity. The circles with numbers depict the students in their respective groups. The gray circles indicate that the person has suffered from malnutrition. The small circle in the lower right section of the graph shows the number of units each student has saved from the three rounds.

The total food supply for each country is determined roughly by per capita income and assumes six groups of 5 students each (with the exception of the Indonesia group which requires 6 students or the participation of the teacher). Please adjust the food supply and distribution to represent the same visual exercise for other class sizes. For example, if there are only 4 people in one group there should be one less unit of rice or millet distributed.

3. Announce Round 1 and pass out the Event Cards for Round 1. Explain that 1980 has been a good year, so all countries are able to eat rice instead of millet. Distribute the rice supply for 1980 to all countries according to the chart on page 79. The units of food should be distributed clockwise so that person number 1 always has first pick of the food supply since he or she represents the most wealthy people of the country while person number 5 represents the poorest of the poor.

   Each student should take one unit of food until the supply for that year runs out. (In some countries, such as Bangladesh, the food supply will not even go around the table once. In other countries, such as Japan, the food supply will be passed around the table clockwise several times.) Units of food per person

exceeding the one nutritional requirement should be saved by that person until the end of the activity.

The Indonesia group should include an additional student or the involvement of the teacher to play the role of the government, which receives two units of rice each round.

Allow groups enough time to read the event cards, eat their food supply (one unit of food per person with any excess amount saved), and reflect on the unequal distribution between the population of their country. Also, have one representative of each group present to the class the amount of food his or her country was able to produce that year and explain whether this was an insufficient, adequate, or a lavish amount of food for their country's population.

4. Announce Round 2 and explain that there have been many changes in the next 15 years. The population in many countries has grown rapidly, and millet has been needed to feed the population. For most people in these countries, their portion of the food supply has decreased because there are now more people to divide the food among. In other countries, new technologies were developed to increase the productivity of the rice crop. Pass out the Event Cards for Round 2 and distribute the food supply for 1995 according to the chart on page 79.

   Allow time for food consumption and for students to reflect on the events impacting their country. One representative from each group should explain to the class the relationship between its country's population and rice production and the resulting food supply. Students should incorporate the information in the event cards into their presentation. Then proceed to Round 3, following the same pattern as in the previous rounds.

5. At the end of Round 3, students should discuss the number of units saved per individual within their groups. They should have time to discuss issues of inequality, the feelings evoked during the course of the activity, the events that occurred over the course of 70 years, and the consequences of those events. There should also be an intragroup comparison about the amount of food, if any, that was left at the end.

   Students should understand that there are other factors that influence population and food distribution that were not included in the event cards. To name a few, education, health, family planning, status of women, economic security, and government policies all impact a country's demographics.

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Year	Bangladesh	China	Indonesia
1980	5 units rice	6 units rice	8 units rice
1995	1 rice, 3 millet	1 rice, 4 millet	4 rice
2050	2 millet	4 millet	2 rice, 1 millet

Year	Japan	Philippines	Thailand
1980	13 units rice	10 units rice	10 units rice
1995	14 rice	6 rice	8 rice
2050	20 rice	5 rice	6 rice

Discussion

1. Begin debriefing by asking each group to share its experience with the rest of the class. How did it feel to be in the different groups? Was there unequal distribution, and how did those who received only millet or who went hungry feel? Which countries had to change from rice to millet production, and why? In what ways did the different countries cope with (or fail to cope with) rising populations?

2. Students should reflect on how population growth, environmental circumstances, and governmental policies impact rice production in Asia and the Pacific. For example, sometimes efforts to increase our standard of living through technology backfire and destroy the resources on which all food production depends. Have the students consider the massive flood that damaged rice crops in Bangladesh in Round 1. Explain that although floods are naturally occurring events, they may increase with global warming, and the damage they cause may increase with deforestation.

   There is often unequal distribution of land and allocation of resources within a country. Explore the cases of Indonesia and the Philippines with the students. Ask the Indonesia group to describe what happened in its country with respect to inequality in Round 1. Ask the Philippines group to explain what happened in its country during Round 3. Discuss the possibility that economic equality and education may slow population growth as in the case of the Philippines. Contrast this to the inequality played out in the Indonesia group during the activity. What role might economic equality play in population and rice production?

3. In addition to inequality within countries, there are also inequities between countries. To show this concept, visually compare the total units of food saved for each country. Many argue that the high consumption of some countries is as much a problem as the high population growth of other countries.

   Discuss the meaning of consumption (see glossary) and ask students to consider the following facts:

- The birth of a baby in the United States imposes more than a hundred times more stress on the world's resources and environment than a birth in Bangladesh.
- Americans comprise 5 percent of the world's population, but use one-third of the earth's resources.
- The average American child (aged 4 to 12) has more pocket money, $230 a year, than half a billion people in the world.

What does this imply about our own lifestyles and our effect on people in developing nations?

4. Conclude this discussion by asking what we can learn about the real countries and their decision-making processes from participating in this activity. The data and events in the activity were purely fictional, but the amounts of food were based roughly on per capita income and current population growth for each country. The events represent possible future scenarios. Review other ideas about what the future may hold:

Country	Future Prediction	Outcome
Bangladesh	environmental degradation as the limiting factor to growth	destruction of earth, massive famine
China	larger population means less food	massive famine
Indonesia	unequal distribution within a country	a few have much, most hungry
Japan	technology increases food; high consumption	plenty for all; may be at expense of others
Philippines	changes in policies, education, women's status, and distribution.	food for all available
Thailand	larger population means less food	hunger, but not massive famine

5. Explain that this activity explored different predictions about the future. Some people believe that the population of the world will continue to grow until the limited resources are completely used up and no one has enough to live. This is called the Malthus Hypothesis, an idea first articulated by a man named Malthus in the 1800s. Innovations and discoveries, according to this hypothesis, only delay population growth. This hypothesis also suggests that population must suffer periodic increases in mortality in the absence of preventative checks such as delayed marriage and decreased fertility rates. The Malthusian model may be summarized as follows:

- The primary resource for people is food. Its scarcity causes mortality to increase, which slows population growth for the time being.
- The law of diminishing returns, which states that when there is an increase in the number of workers employed on

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limited land their productivity will decrease, is unavoidable. Cultivation of new land and increased labor in response to population growth adds smaller increments to production for each additional unit of labor.

- Increased production or productivity as the result of innovation and technology provides only temporary relief to the problem of population growth.
- An awareness of the cycle of population growth may lead a population to check its fertility rate by restraining marriage.

6. The opposing theory to that of Malthus suggests that as population increases, development is stimulated. This theory argues that the Malthus theory ignores the effects of population growth on both the environment and technology. Where the Malthus Hypothesis is a more catastrophic view of population growth, this opposing theory, most recently expressed by Ester Boserup, is a more optimistic view.

   Boserup's theory explains that population growth creates the conditions necessary for innovation. For example, population pressure forces farmers to use new techniques and technology to feed a greater number of people. Therefore, innovation can be seen as the result of population growth and the fact that the maximal population density has been attained in a given area. Boserup's theory explains that population growth is one of the driving forces of technological advancement and economic transformation.

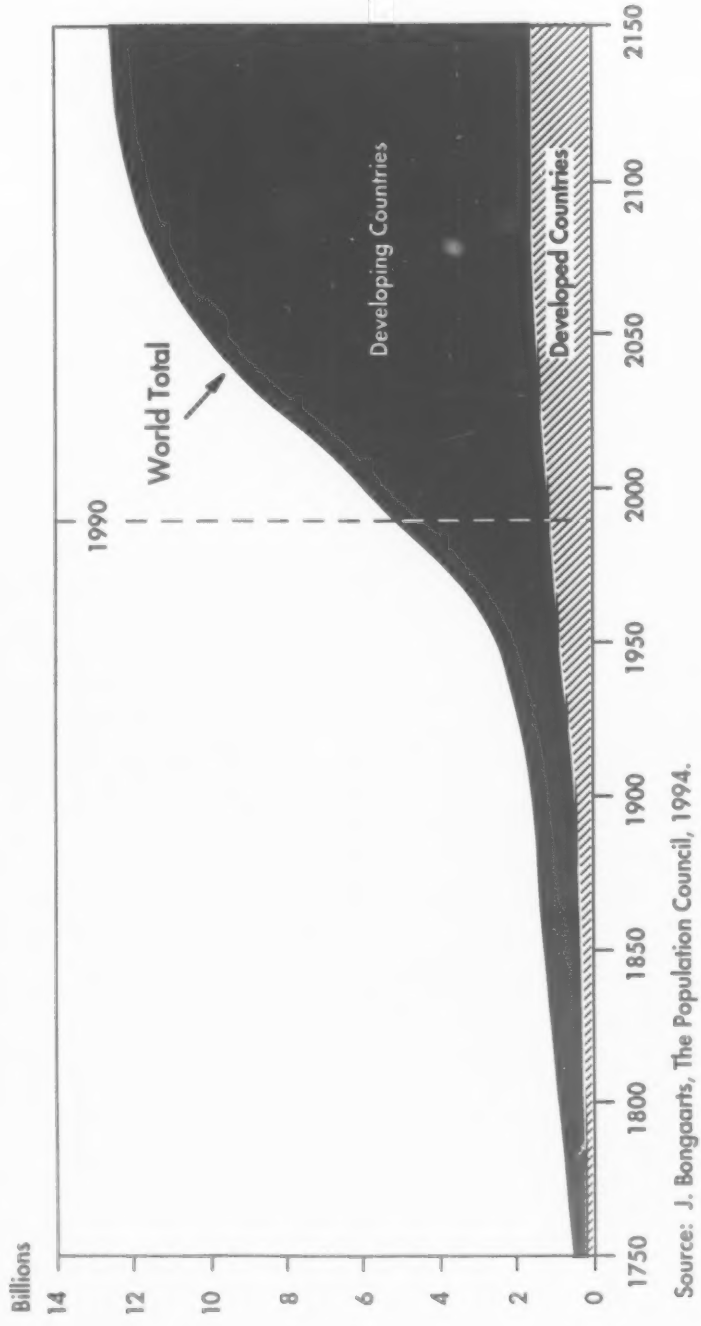
7. Discuss these theories with students and explain that there are also other ideas about how the future will play out. Some people believe that our population will continue to grow but will never reach the kind of crisis described by the Malthus Hypothesis because our technology will help us increase our food and resources. Others believe that our current rate of population growth and environmental degradation are leading us toward a major crisis. What do you think? Could it be a combination of scenarios? What would you predict for your group's country?

8. The teacher may wish to have the students synthesize the information presented in this activity for individual homework. Students should think about how the Malthus Hypothesis and the Boserup Hypothesis do or do not apply to population growth in Asia and the Pacific.

   Students should also consider how their own attitudes have been shaped by this lesson.

transparency

World Population Projections, 1750–2150



Source: J. Bongaarts, The Population Council, 1994.

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country information sheet #1

BANGLADESH

You should have three sets of egg carton sections, each of which contains one cup. You will use one of these for each round during the activity. Label them 1980, 1995, and 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton section aside and use a new one for the next round.

Round 1: 1980

Your population is 90 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has grown over the past 15 years. Now it is 110 million people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the new population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg carton. Compare 1995 with the 1980 set.

Round 3: 2050

Your population has grown yet again, and it is now 170 million. Place the corresponding number of popped corn kernels into the third set of egg carton sections. All the popcorn must fit into the egg carton sections.

Compare all three sets of egg carton sections.

Other information:
In 1995, the average woman in Bangladesh had five children.
The population density is 2,300 people per square mile.

country information sheet #2

China

You should have six sets of egg carton sections, each of which contains 12 cups. You will use two of these for each round during the activity. Label two of them 1980, two of them 1995, and two of them 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton sections aside and use new ones for the next round.

Round 1: 1980

Your population is 900 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has grown over the past 15 years. Now it is 1.2 billion people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the new population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg cartons. Compare 1995 with the 1980 sets.

Round 3: 2050

Your population has grown yet again, and it is now 1.6 billion. Place the corresponding number of popped corn kernels into the third set of egg carton sections.

Compare all six sets of egg carton sections.

Other information:
In 1995, the average woman in China had one child.
The population density is 327 people per square mile.

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country information sheet #3

INDONESIA

You should have three sets of egg carton sections, each of which contains four cups. You will use one of these for each round during the activity. Label them 1980, 1995, and 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton section aside and use a new one for the next round.

Round 1: 1980

Your population is 150 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has grown over the past 15 years. Now it is 180 million people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the new population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg carton. Compare 1995 with the 1980 set.

Round 3: 2050

Your population has grown yet again, and it is now 240 million. Place the corresponding number of popped corn kernels into the third set of egg carton sections.

Compare all three sets of egg carton sections.

Other information:
In 1995, the average woman in Indonesia had three children.
The population density is 270 people per square mile.

country information sheet #4

JAPAN

You should have three sets of egg carton sections, each of which contains three cups. You will use one of these for each round during the activity. Label them 1980, 1995, and 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton section aside and use a new one for the next round.

Round 1: 1980

Your population is 120 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has remained the same over the past 15 years. It is still 120 million people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the 1995 population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg carton. Compare 1995 with the 1980 set.

Round 3: 2050

Your population is still 120 million. Place the corresponding number of popped corn kernels into the third set of egg carton sections.

Compare all three sets of egg carton sections.

Other information:
In 1995, the average woman in Japan had between 1 to 2 children.
The population density is 860 people per square mile.

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country information sheet #5

PHILIPPINES

You should have three sets of egg carton sections, each of which contains 2 cups. You will use one of these for each round during the activity. Label them 1980, 1995, and 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton section aside and use a new one for the next round.

Round 1: 1980

Your population is 50 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has grown over the past 15 years. Now it is 60 million people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the new population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg carton. Compare 1995 with the 1980 set.

Round 3: 2050

Your population has grown yet again, and it is now 90 million. Place the corresponding number of popped corn kernels into the third set of egg carton sections. All the popcorn must fit into the egg carton sections.

Compare all three sets of egg carton sections.

Other information:
In 1995, the average woman in the Philippines had four children.
The population density is 560 people per square mile.

country information sheet #6

THAILAND

You should have three sets of egg carton sections, each of which contains four cups. You will use one of these for each round during the activity. Label them 1980, 1995, and 2050, so that you can remember which egg cartons represent which years. Once you have completed a round, be sure to set the egg carton section aside and use a new one for the next round.

Round 1: 1980

Your population is 50 million. Place unpopped kernels representing this number into one set of egg carton sections. Remember: each kernel represents 5 million people.

Round 2: 1995

Your population has grown over the past 15 years. Now it is 60 million people, and you must place popped kernels representing this number into the second set of egg carton sections.

Remember that each popped kernel represents twice as many people as an unpopped kernel. First, figure out how many unpopped kernels you would need to represent the new population, then divide this number in half to get the amount of popped corn you will put in the 1995 egg carton. Compare 1995 with the 1980 set.

Round 3: 2050

Your population has grown yet again, and it is now 70 million. Place the corresponding number of popped corn kernels into the third set of egg carton sections.

Compare all three sets of egg carton sections.

Other information:
In 1995, the average woman in Thailand had 3 children.
The population density is 300 people per square mile.

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Event Card: Round 1

BANGLADESH

Your portion of the rice produced this year is 5 units. However, you have been cutting down your forests to use the wood as fuel because you have no other alternatives. The trees were important in holding together the soil, but because they are now gone, there was a massive flood this year that ruined one-fifth of your rice crop. You must return one-fifth of your rice supply.

Event Card: Round 1

CHINA

Although your population is far greater than any other country in your part of the world, your rice production is also higher than the other countries because you plentiful land and labor. Your portion of the rice crop this year is 6 units.

Event Card: Round 1

INDONESIA

Your portion of the rice crop this year is 8 units. The government is concerned with maintaining adequate stocks of rice for emergencies or sale. For each of the next three rounds, you must return two units of rice as taxes to the new government.

Event Card: Round 1

JAPAN

As people in one of the few industrialized countries in Asia and the Pacific, you have the money to buy rice, or most anything else, if your country does not produce it. Because you have so much money, you live better than your neighbors—you use more energy, buy more products, and eat more and better food. Rice production is lower this year than in other years, but you buy enough so that there is plenty for all. Your portion of the rice crop this year is 13 units. Collect two additional rice units from the Philippines.

Event Card: Round 1

PHILIPPINES

You have been relatively successful in increasing your crop yield this year by using chemical fertilizers and pesticides. Your portion of this year's crop is 10 units of rice. However, you decide to sell some of your food to buy imported products. Give 2 units of rice to Japan.

Event Card: Round 1

THAILAND

Relative to other "developing" countries, you have a higher income per person and standard of living. Rice farmers constitute a large proportion of your population, so production is keeping ahead of your population growth. Your portion of this year's crop is 10 units of rice.

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Event Card: Round 2

BANGLADESH

Your population is growing at an extremely rapid rate, and floods continue to harm rice production so that it is unable to keep up with the growth in numbers of people. This year, you will have to eat some millet in addition to rice in order to get enough to eat. Your portion of this year's crop is 1 unit of rice and 3 units of millet.

Event Card: Round 2

CHINA

Although your population is not growing as fast as in other countries, the sheer numbers of people in the country mean that there are millions of new mouths to feed now. The water needed to grow rice is becoming contaminated because of pollution. Your rice crop yield has not increased as much as the population, so you have to supplement your diet with millet this year. Your portion of this year's crop is 1 unit of rice and 4 units of millet.

Event Card: Round 2

INDONESIA

The government continues to keep a portion of rice stock for emergencies and sale to raise foreign currency. Per capita rice production has declined, and population has grown. Your portion of this year's crop is 4 units of rice. Remember that you must return 2 units of your rice supply to the government.

Event Card: Round 2

JAPAN

Your portion of this year's rice crop is 14 units. However, you have been developing new technology for increasing the amount of rice that will grow on a small piece of land. Even though you still have the same amount of land to grow rice on as in previous years, you have increased your rice crop yield with this new technology. Collect an extra 3 units of rice.

Event Card: Round 2

PHILIPPINES

Your population continues to grow, but the government has been discussing the possibility of land reform and education programs to decrease the birth rate. More girls and women now receive education, and greater employment opportunities are opening up to women. The standard of living continues to decline, however, due to the increasing population. Your portion of this year's crop is 6 units of rice.

Event Card: Round 2

THAILAND

Your population is growing and putting increased pressure on the water, soil, and other resources necessary for producing a plentiful rice crop. Because your population's birth rate is only slightly higher than the death rate, the population increase is not as drastic as in some countries. Your portion of this year's crop is 8 units of rice.

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Event Card: Round 3

BANGLADESH

Global warming has caused the sea level to rise, and devastating tropical storms hit. The floods due to storms are made worse by earlier deforestation, and floods continue to be a problem in destroying rice crops while your population continues to increase at an alarming rate. So little rice was harvested this year that you must eat only millet. Your portion of this year's crop is 2 units of millet.

Event Card: Round 3

CHINA

Your population continues to increase. The increased population, combined with changes in land use from agriculture to industry, have caused the water to become contaminated by waste, the nutrient levels in the soil to decline, and the production of rice to drop. However, you believe that new agricultural technology being developed will help remedy the problem soon, so you take no action. Your portion of this year's crop is 4 units of millet.

Event Card: Round 3

INDONESIA

Per capita grain production continues to decline, and some people protest that they do not have enough to eat. Your population has increased even more. Your portion of the crop this year is 2 units of rice and 1 unit of millet. The government has decided to exact a tax of 2 units of rice.

Event Card: Round 3

JAPAN

You continue to be a major player in the world economy with one of the highest standards of living in the world. Because your birth rate is so low, your population has actually decreased slightly in the past few years. Your consumption level is very high, so you use more energy and eat more and better food than people in other countries. Your portion of this year's crop is 17 units of rice, and you get 3 units of rice from other countries.

Event Card: Round 3

PHILIPPINES

Your portion of this year's crop is 3 units of rice. However, your government has succeeded in passing laws to equal out the distribution of land among people. They also began a massive public health and education program. Women's status has gone up in recent years. People are more secure economically and did not have as many children during this time period as in the previous years. Your population is lower than predicted for this year. Collect an extra 2 units of rice.

Event Card: Round 3

THAILAND

Your productivity and standard of living are still high relative to your neighbors, but your population is increasing and putting more and more pressure on the water, land, and other resources needed to produce a healthy rice crop. You believe, however, that there is much time ahead to find ways to compensate for the damage, so you continue as usual. Your portion of this year's crop is 6 units of rice.

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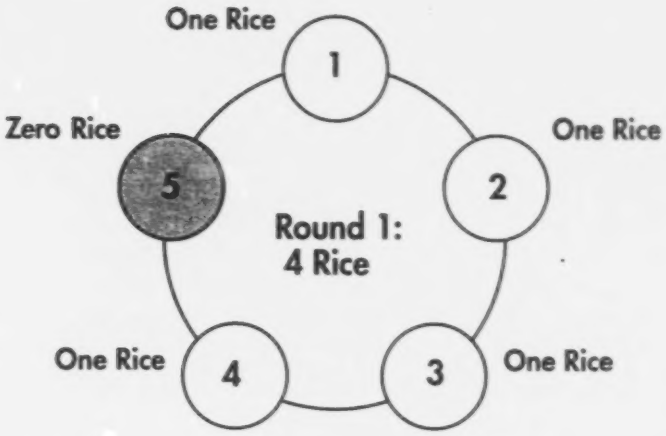
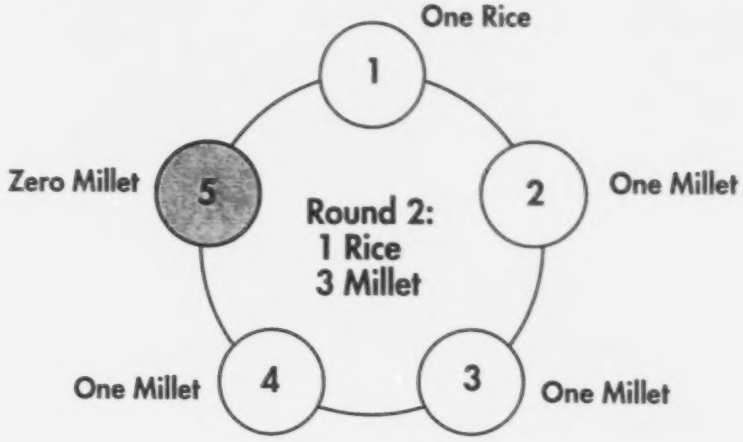
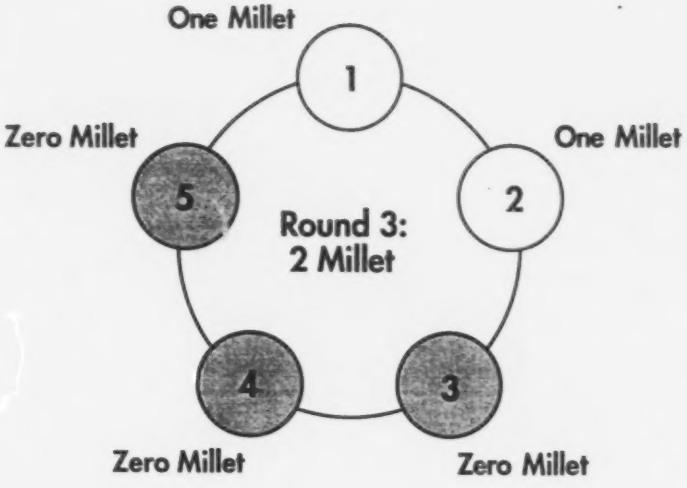
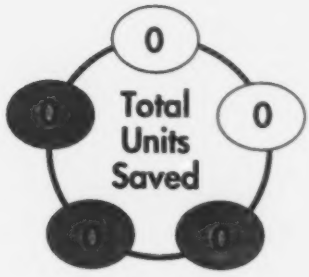
COUNTRY CIRCLE DIAGRAMS: BANGLADESH

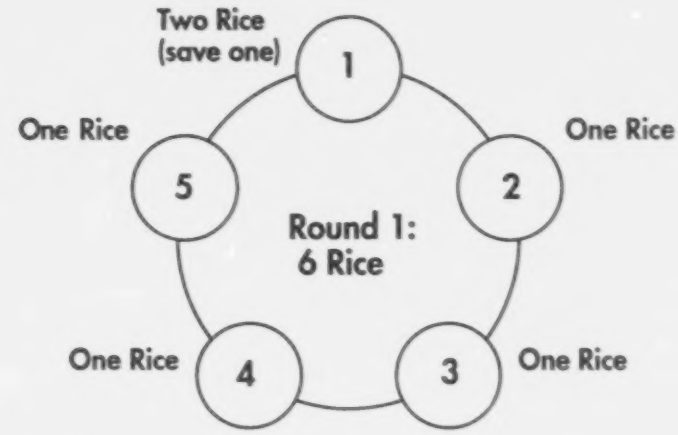


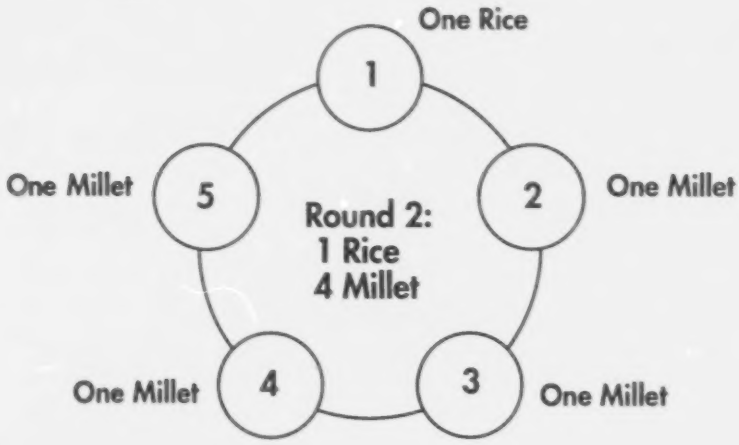


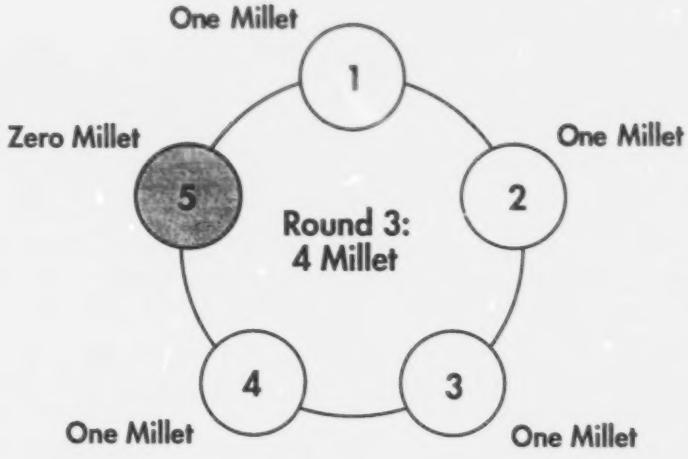


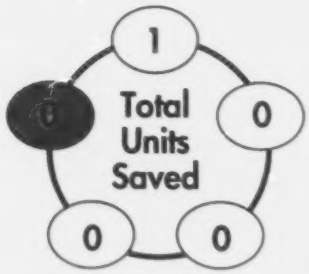


COUNTRY CIRCLE DIAGRAMS: CHINA









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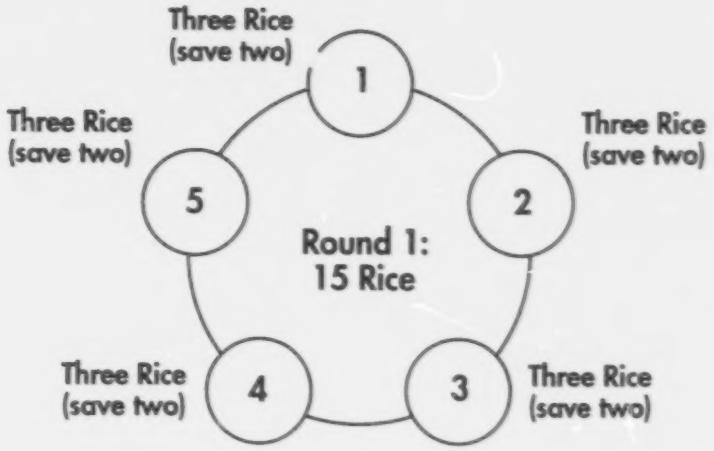
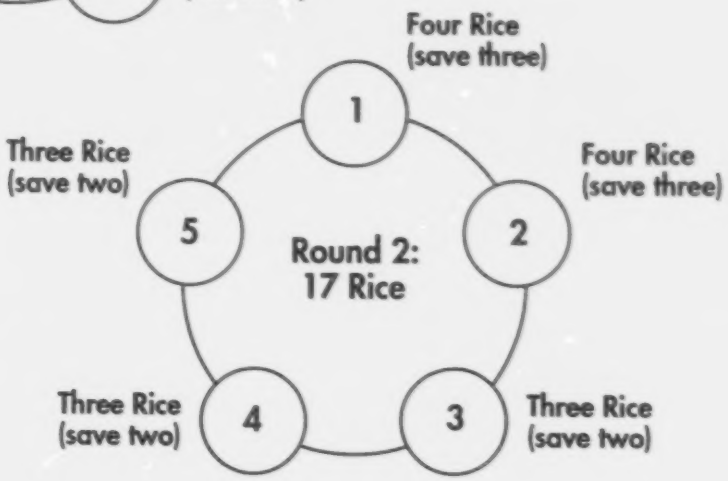
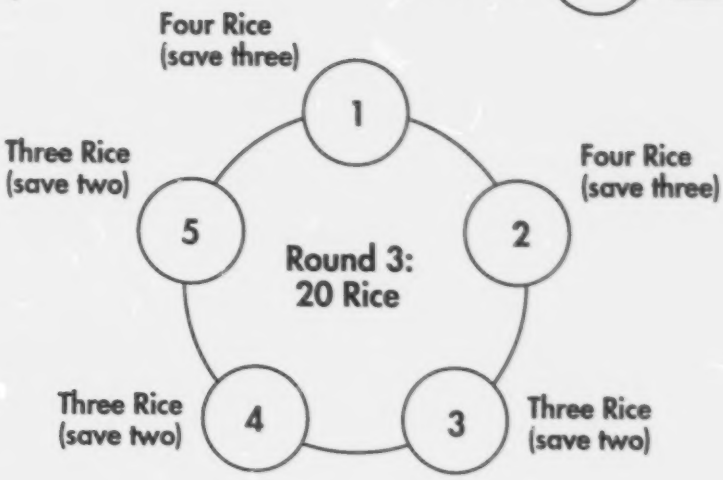
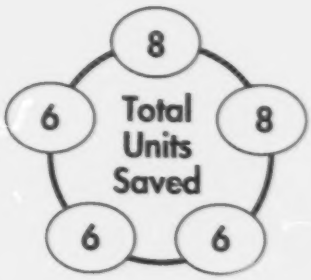
COUNTRY CIRCLE DIAGRAMS: JAPAN

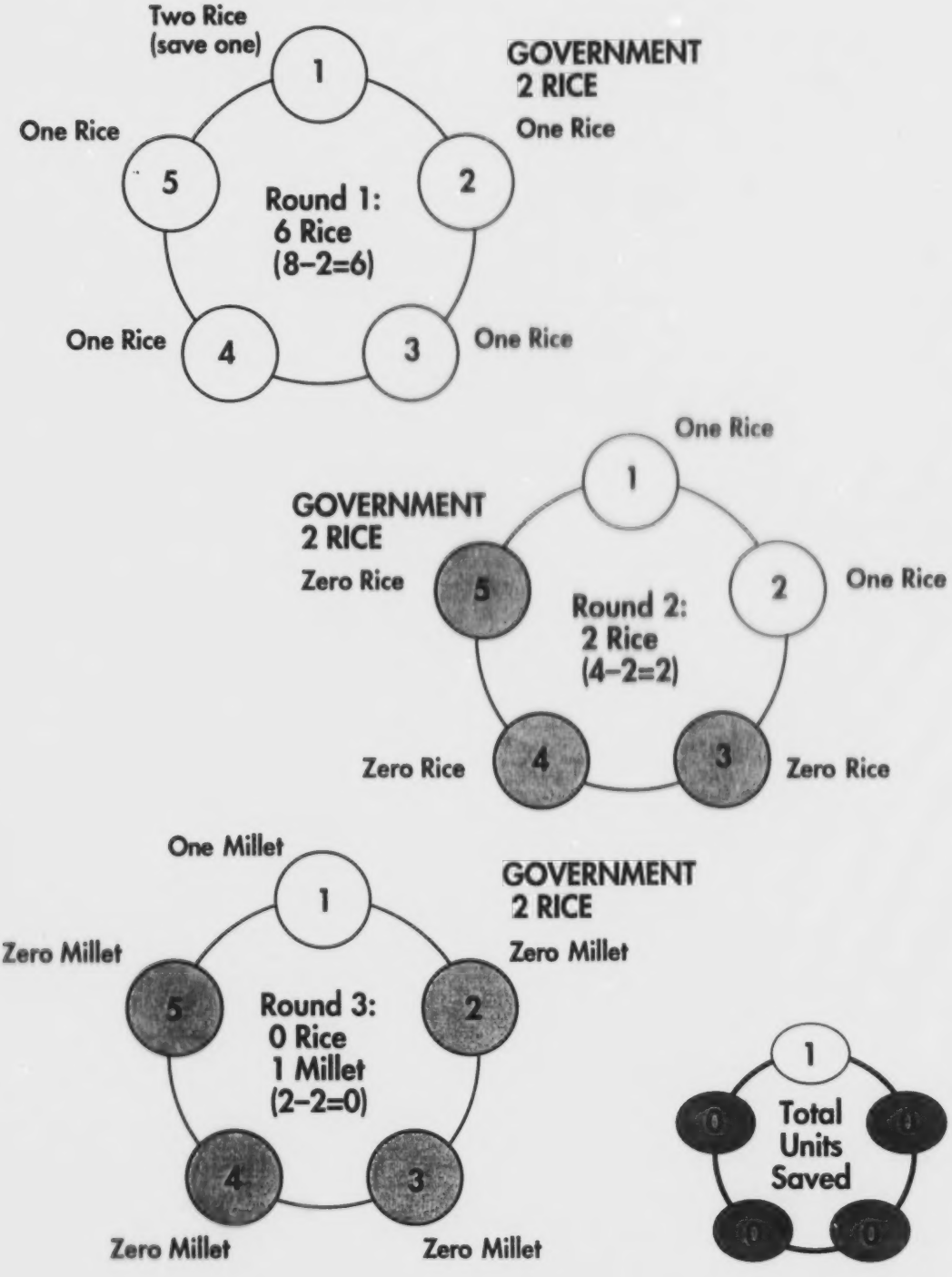








COUNTRY CIRCLE DIAGRAMS: INDONESIA



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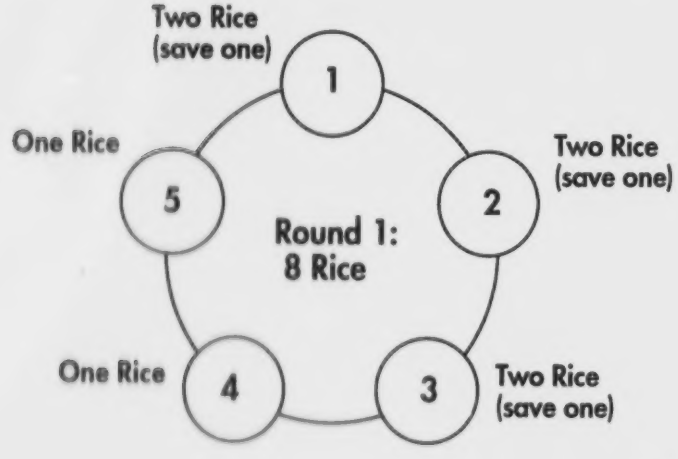
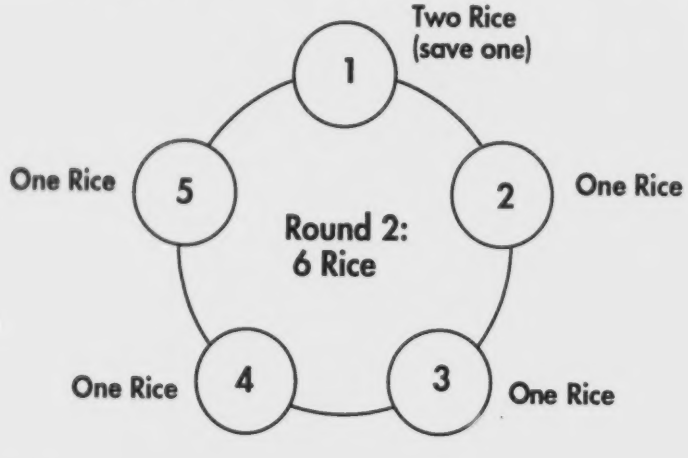
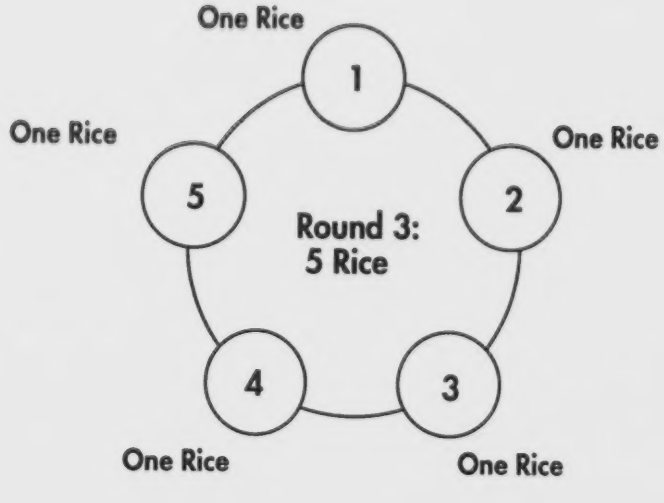
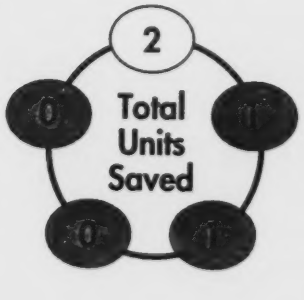
COUNTRY CIRCLE DIAGRAMS: PHILIPPINES

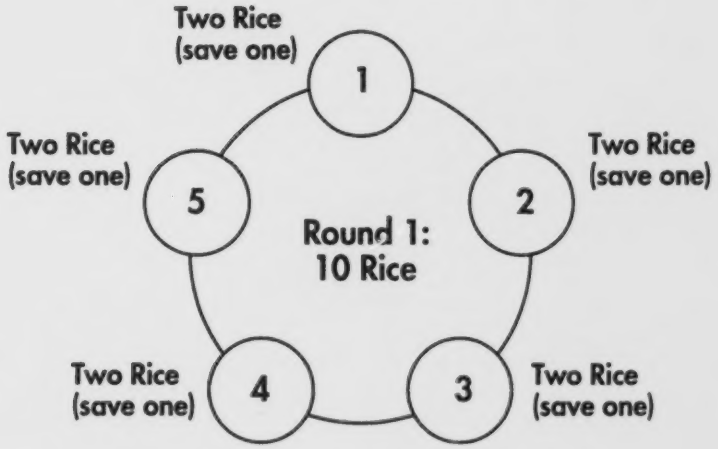


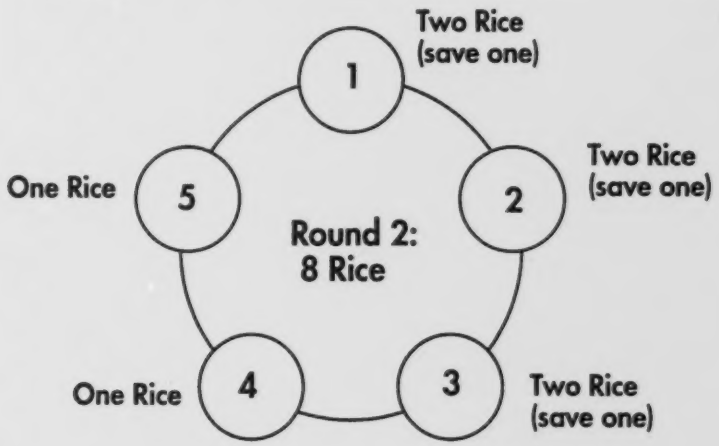


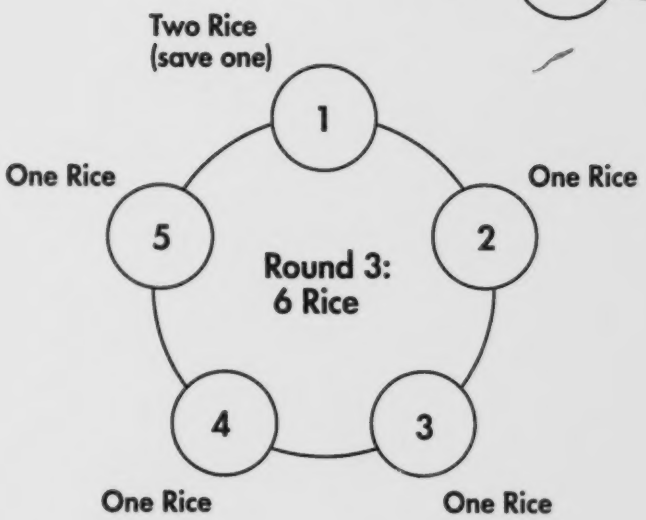


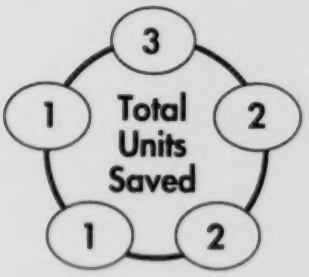


COUNTRY CIRCLE DIAGRAMS: THAILAND









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Lesson 4

TECHNOLOGY AND RICE

Organizing Questions

- How can we use technology responsibly to produce enough rice for now and the future?
- How can we increase production while ensuring that future generations will also be able to meet their needs?

Introduction

> Economic growth and rising labor costs in many regions of Asia have led to the widespread adoption of herbicides in rice production. This trend has been reinforced by the spread of direct-seeded rice technologies that require chemical weed control in the early stages of crop growth to prevent substantial yield losses. Herbicide use has been shown to be privately profitable for Asian rice farmers, but the question remains as to whether it is socially profitable when environmental costs, health costs, and the societal costs of labor displacement in some economically stagnant regions are accounted for (Rosamond Naylor, "Herbicide Use in Asian Rice Production," *World Development*, Vol. 22, No. 1, pp. 55–70.)

As we have seen in lessons 1 and 2, rice plays a vital role in the diet, economy, culture, and survival of the many different Asian and Pacific peoples. Lesson 3 introduced the need to increase rice production as the population increases in order to alleviate hunger and raise the standard of living of all people. As lesson 4 will explore, however, the technology that often accompanies an increase in production must be used wisely and responsibly. In the long term, certain technologies can undermine our ability to sustain rice production. These technologies can endanger the basic natural and agricultural resources such as water, land, and biodiversity if not selected and implemented cautiously.

We tend to think only of machines when we hear the word *technology*, but in agriculture, technology also includes special methods of growing, materials added to enhance the soil, and plant breeding to improve the varieties of rice available. In this lesson, students will study a rice farm in Indonesia, exploring different growing methods and technologies as well as their environmental and social trade-offs. After learning about the parts of the rice plant and its growing cycle, students will role-play teams of scientific and agricultural experts analyzing the technological needs of a farm in Indonesia. Each team will create a rice production plan for this

farm, and then present that system in the form of an advertisement and commercial. Finally, all the teams will decide which rice production plan should be adopted for Indonesia.

Objectives

knowledge

- to distinguish rice yield growth from area expansion and learn why farmers today primarily focus on increasing rice yields
- to learn about the different technologies available to farmers for increasing their rice production
- to consider the different applications and availability of rice technologies in six countries of Asia and the Pacific
- to learn about the advantages and disadvantages of rice technologies used in Asia and the Pacific

attitude

- to appreciate various perspectives on technology in rice production
- to re-examine assumptions about agricultural technologies
- to consider the environmental and social trade-offs of rice technologies
- to recognize the importance of providing for the needs of both the present and future generations

skill

- to analyze and interpret primary and secondary source documents
- to work effectively in small groups
- to make decisions about the uses of technology in rice production
- to creatively express ideas and goals through art and acting

Time

1 period (50 minutes) for introduction, analyzing resources and preparing presentation

1 period for group presentations and class decision

Materials

- 5 posters: Rice is planted in many ways; Rice is harvested in many ways; Rice is handled in many ways; Rice is distributed in many ways; Rice is sold in many ways
- 5 pieces of posterboard (1 for each group) or other presentation materials such as overhead transparencies, projector, white-board, and computer programs such as Hypercard and PowerPoint
- markers, crayons
- construction paper, scissors, tape, glue

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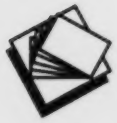
- props for skits
- Handout #1: 110-Day Rice Cycle, 1 per student
- Handout #2: Indonesian Farm Profile, one per group
- Handout #3: Designing a Rice Production Plan for Indonesia, 1 per group
- Technology Chart: Some Suggested Answers, for the teacher
- Resource Card #1: Rice Variety Summary, one per group
- Resource Card #2: Planting System Summary, one per group
- Resource Card #3: Machinery Summary, one per group
- Resource Card #4: Input Summary, one per group
- Handout #4: Rice Growth and Production, one per student (Optional)

Procedure

1. Point out that as we have seen in the first three lessons, rice is vitally important in the lives of people in Asia and the Pacific. Pose the question: Will we be able to grow enough rice for everyone in the future? Despite recent gains in our ability to produce rice, researchers and scientists foresee the need to increase rice production even more in order to feed the growing Asian and Pacific populations. The purpose of this lesson is to demonstrate that the technology often associated with increases in production must be used wisely and responsibly. These technologies usually have trade-offs that may threaten our ability to sustain the increased production.
2. Begin the discussion of technology with the question: How can we grow enough rice for now and the future? A probable response is that we can simply bring more land into agricultural production to grow more rice, often called "area expansion." Ask students to recall what happened in lesson 3 during the activity with the popcorn population and egg cartons. How were the egg cartons analogous to the actual countries? Discuss the fact that the land available for rice production in most of Asia and the Pacific is finite—the egg cartons did not increase in number or expand despite the increase in popcorn. The area of land used to grow rice usually cannot be expanded because it is already being used for other purposes and is not available for use in rice production. An exception to this is when natural wetlands and forests are developed into farmlands, which involves other complicated issues of habitat destruction and loss of biodiversity (to be discussed in lesson 5). To increase production, then, farmers must increase the amount of rice they can grow on a given amount of land, that is, increase the *yield*. Discuss the concept of yield in terms of rice: when the same amount of land is used but a greater amount of rice is produced, the land has a higher yield of rice.

3. Lead a brief discussion about students' ideas of what constitutes *technology*. What do students think of when discussing technology in food production? What purpose does it serve? Brainstorm what technologies students have seen on farms, in the grocery store, on the news. Using the five posters (Rice is planted in many ways; Rice is harvested in many ways; Rice is handled in many ways; Rice is distributed in many ways; Rice is sold in many ways), help students to expand their definition of technology to include more than machinery; it can include the actual methods used to grow the food, materials or chemicals that are added to the soil to help plants grow, vitamins and antibiotics fed to animals, and plant and animal breeding to improve the plants and animals themselves. Encourage students to comment on the similarities and differences between the two photographs on each poster.

4. Divide students into five groups and explain that they will work together as teams of scientists and engineers (specializing in agricultural technologies). Distribute a copy of Handout #1, 110-Day Rice Cycle. Discuss the steps in the growth cycle of the rice plant, and at which steps students imagine using the technologies they've brainstormed. You may choose to use Handout #4: Rice Growth and Production, for a more in-depth description of how rice is grown, but this is optional.



5. Distribute Handout #2, Indonesian Farm Profile, and Handout #3, Designing a Rice Production Plan for Indonesia, to each group. The students' task is to create a rice production plan using various technologies to increase production on Indonesian farms while also ensuring that the production is sustainable over the long term. Make sure students understand their task before distributing Resource Cards #1–4 to each group.

6. Allow each group 30-40 minutes to work through the documents and create the advertisements and commercials. Provide materials for presentations, posters, and skits.

7. Ask students in each of the teams to perform their commercial/skit for the other groups and answer questions other students have about their system.

8. Once all five groups have made their presentations, announce that the teams need to decide which rice production system will be best suited for the Indonesian farm. You may want to simply have students vote on the system they think is best, or you can have students determine another way to make the group decision. Ask students what the different methods of making group decisions are (consensus, two-thirds majority, strict majority, elected representatives from each group decide, etc.) and decide which method they will use.

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9. Place the posterboards and other visuals where everyone can see them. You may want to ask students to help make a list on the chalkboard of the different kinds of technologies used in the different systems. Begin a discussion about the plans by inviting comments and comparisons. What are the differences between the plans proposed by each team? Did one team have information that others did not have? For each system, encourage students to return to the central questions: Will it increase rice production? Does it consider the need to sustain the production in the future?
10. Use the decision-making method agreed upon earlier to choose the rice production plan for Indonesia.

Discussion

1. Debrief by asking students if their attitudes about technology in agriculture changed during the course of the activity. What do they see as the best use of technology? What did they learn about the decisions rice farmers must make? Are they confident that their rice production system for Indonesia will provide for both now and the future?
2. Ask students how they decided which technologies to use in their plans. Are there other factors in an actual farm that would influence those decisions? Discuss economic constraints as important determinants of what a farmer decides to do. Machinery is extremely expensive, particularly for people in developing countries like Indonesia who earn, on the average, the equivalent of $600 a year. Seeds are expensive. Chemical fertilizers and pesticides are also costly because they are usually produced by large companies outside the country and must be transported long distances. Ask students how their decisions would have been different had they known how expensive some of the technologies are?
3. Ask students if they are confident that their system would work for the other Asian and Pacific countries studied in this curriculum unit. What are some of the differences between farms in Indonesia and those in other countries that might make the system less effective? (These might include different conditions, terrain, climate, seasons, pests, politics, or labor). Emphasize the notion that a system that works for one country may not be appropriate for another. Also, bring up the idea that there are different types of rice production. Although irrigated rice paddies are most common in Asia and the Pacific, rice is also grown "dry" on sloping hillside fields where the availability of water is limited and as "floating" rice in areas with large quantities of water year-round. These various rice ecosystems will be discussed in depth in lesson 5.
4. Ask students to speculate about how agricultural technologies might be different in the United States than in Asia and the Pacific. Explain that we often assume that more machinery

means that a system is more modern and therefore better. In Asia and the Pacific, there is an abundance of labor and limited machinery, and the terrain is often very different from the United States, so more machinery may not necessarily be "better" for rice production. Give an example from the activity that illustrates a situation where using human labor may actually be better than machinery for rice farming (arguably: harvesting, weeding, and/or transplanting instead of broadcast seeding).

5. Close by asking students to list briefly some of the advantages and trade-offs of agricultural technologies in rice production. Compare these lists to their original lists on Handout #3, Designing a Rice Production Plan for Indonesia, to see if their knowledge or attitudes have changed due to the discussion.

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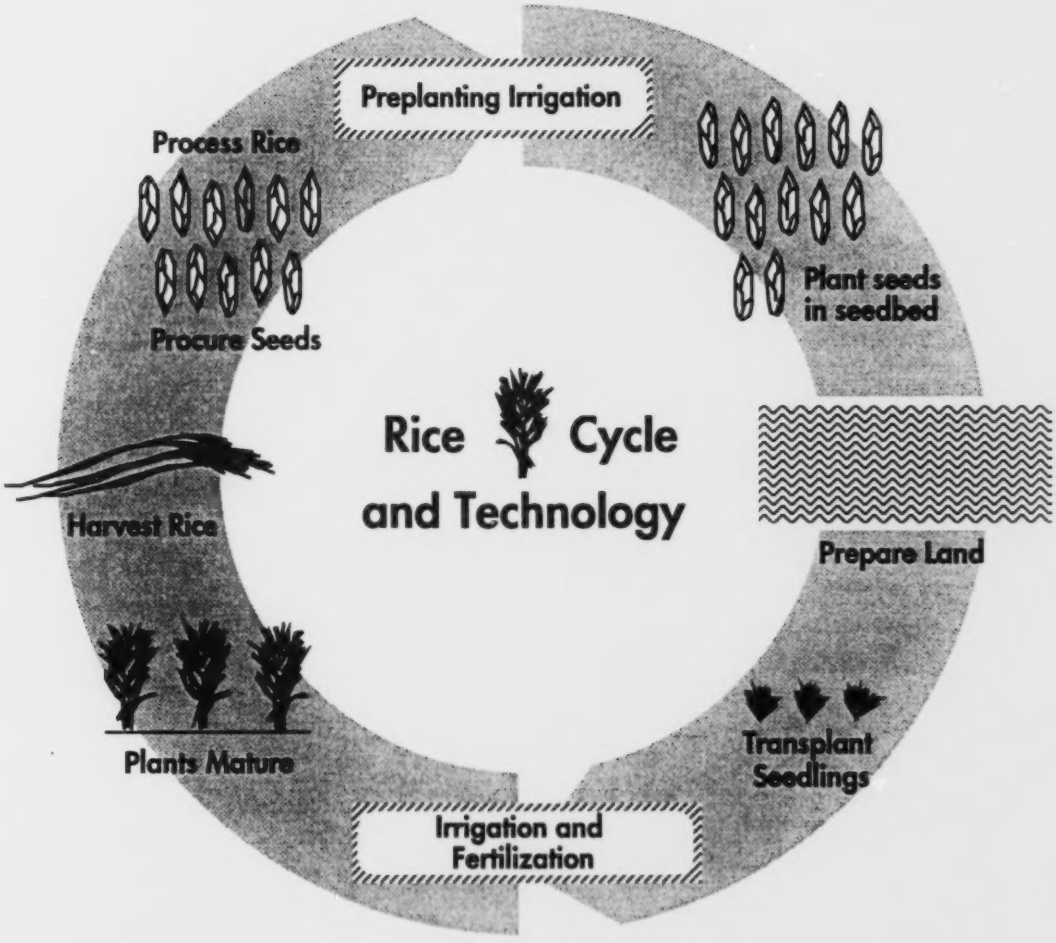
110-DAY RICE CYCLE



handout #2

INDONESIAN FARM PROFILE

Tri Mardjoko is a typical rice farmer from the village of Tempurejo, located in the district of Wates, Kendiri County, in the province of East Java. He was interviewed about his farm and the technologies he currently uses.

Here are his answers to following questions:

- How long have you been a rice farmer?
  15 years
- How large is your rice field?
  0.5 hectares
- Who else besides you works on the farm?
  Wife and three children, hired workers from the village
- Is it easy or difficult to find labor when you need it?
  Difficult at the time of planting and sometimes at harvest. Weeding is also becoming more difficult to find labor.
- Describe briefly the crop cycle on your farm.
  5 rice crops every 2 years. Some years soybeans or maize is grown in the dry season.
- How do you get water to your fields?
  Irrigation from central district system.
- What are the major threats to your crop? pests?
  Brown planthopper, weeds, decreasing fertility of soil, increased salinity.
- Do you use fertilizer? What kind? How much?
  Yes, nitrogen, phosphorus, potassium.
- Do you use pesticides? What for? How much?
  Insecticides occasionally for brown planthopper. Beginning to use herbicides since labor is becoming more scarce for weeding.
- What kind of machinery (if any) do you use to help you farm?
  2-wheeled tractor for land preparation, mechanical thresher for harvesting.
- What kind of rice seeds do you plant? Do you buy them every year?

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IR64 (International Rice Research Institute variety). Mostly I save seeds from my own production. When I change varieties, I purchase seeds from a government extension agent.

- If you could change anything about your farm, what would it be? (for example, machinery? more fertilizers? etc.)

  Better water control, less salts in water, better pest control. I feel a strong obligation to keep hiring village women to work in the fields. Some other farmers in villages are opting to substitute for labor with herbicides and direct-seeded rice. I will only do this when labor is impossible to find (at an affordable price for me).

handout #3

Designing a Rice Production Plan for Indonesia

Indonesian rice farmers want to begin to use more technology to increase production. You are a team of scientists and engineers who have been called together to suggest a Rice Production Plan that: 1) increases the rice production of the Indonesian farm using technologies that work well together; 2) will help achieve higher yields; and 3) will ensure that the land and water are healthy enough to support production for many years.

1. Examine the Indonesian Farm Profile, The Rice Cycle, and Resource Cards #1–5. To help you compare the pros and cons of each technology option, fill in the chart below by deciding on the technology's advantages and disadvantages.

Technology Category	Technology Option	Advantages	Disadvantages
Rice Varieties			
Planting System			
Machinery			
Inputs (fertilizers, pesticides, herbicides)			

2. To design your Rice Production Plan, select the technologies from each category that your team thinks will be the best combination for increasing production of rice on the Indonesian farm. Keep in mind that you can always suggest hand labor or no technology at all for a particular category. You may also choose more than one technology per category, but remember that you must be as economical as possible, and that money spent on agriculture is money that might otherwise be spent on health care, education, or industrial development.
3. Use the posterboard and other materials to present your plan to the other teams working on this task. Your final presentation should include a commercial or skit that explains your plan and convinces the Indonesian farmers that your plan will be the most effective.

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TECHNOLOGY CHART: SOME SUGGESTED ANSWERS

Technology Category	Technology Option	Advantages	Disadvantages
Rice Varieties	traditional variety mix	adapts to seasonal weather variations	less hardy, lower yield than HYVs
	high yield varieties (HYVs)	high yield with chemical fertilizers, hardy, multiple cropping	need chemical fertilizers, not adapted to local conditions, expensive
Planting Systems	broadcast seeding	saves labor, used with herbicides	lower yield, pest control different without pesticides, herbicides
	transplanting	strong root systems, more rice grows, easier pest and weed control	takes time and labor
Machinery	none	uses readily available labor	hard work, maybe lower yields due to timing
	irrigation pumps	water control, can intensify production with HYVs	expensive investment
	tractors (land preparation)	saves time, possibly increases yields due to better timing of labor	small land size makes maneuvering difficult
	transplanting machine	saves much time	expensive, may not be adapted to local conditions, machine maintenance
	combine-harvester	saves time	not as precise as with sickles
	small-scale tiller	saves time, easier maneuvering than large tractors	expensive to buy, problems with machine maintenance
Inputs	none	little or no contamination of resources, uses labor	not as high yield, pest and weed problems, high labor
	organic fertilizer	cheap, local, no contamination, good for traditional varieties	must be properly treated to kill pathogens
	chemical fertilizer	high yields with HYVs	contamination of resources, expensive
	chemical pesticide	increases yields by fending off pests	expensive, contamination of resources, health hazards
	chemical herbicide	saves time and labor for weeding	costly, contamination of resources in food chain

resource card #1

RICE VARIETY SUMMARY

Traditional Variety Mix

There are approximately 120,000 cultivated varieties of Asian rice. Traditionally, farmers did their own plant breeding and grew different rice varieties. This allowed them to:

- adapt to seasonal weather variations (for example, later rains required for a quick-ripening variety)
- rotate the varieties they used so that no one variety could be wiped out by disease
- produce rice for ceremonial and other cultural uses
- distribute labor and water needs more evenly over time (because different varieties require peak labor and water at different times)
- increase their income (by selling some varieties and eating others)

High-Yield Varieties (HYVs)

Since the "Green Revolution" of the 1960s (during which western scientists set out to meet food demands in the developing world through technological innovations to increase food production), HYVs of rice are increasingly being planted instead of more traditional mixes of rice varieties. The HYVs:

- mature quickly, so if water is available, production can increase to two or three crops of rice in a single year
- produce more rice grains per plant—yield increases 10 to 160 percent over traditional varieties
- are shorter and sturdier so that they won't fall over when there is more rice on the stalk
- respond well to chemical fertilizers (with nitrates and phosphates, HYV yields may double), but are dependent on them because without fertilizers their yields are often less than traditional varieties
- are bred to be resistant to several diseases and pests
- have seeds that must be purchased from farm associations and labs every year and cannot be saved from the previous year's crop (this makes them very expensive relative to traditional varieties)
- are often not well adapted to local conditions because they were developed for large-scale distribution throughout Asia and the Pacific
- are sometimes more vulnerable to disease because pests quickly adapt to different plants and because a monoculture crop does not have the biodiversity to protect it

With increasing populations and an often shrinking agricultural land base, scientists are working to improve the HYVs using conventional plant breeding techniques as well as genetic engineering and biotechnology.

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PLANTING SYSTEM SUMMARY

Broadcast Seeding

Broadcast seed planting involves sowing seeds directly onto the fields. This is easier than transplanting and does not require the same kind of labor or time, but in the long run, not as many seeds become mature rice plants. Because of the rise in the cost of labor, farmers in many parts of Asia are considering direct broadcast planting and using herbicides to substitute for labor.

Transplanting

Most wet-rice farmers in Asia and the Pacific currently transplant their rice seedlings to the fields either by hand or by using a Japanese-developed transplanting machine. The seeds are first sown in a prepared seed-bed and transplanted to the field in even rows. This results in higher rice yields by strengthening the root system of plants, encouraging more rice grains, and allowing for easier weeding and pest control.

According to some rice researchers, a switch from broadcasting to transplanting will easily increase yields by 40 percent.

resource card #3

MACHINERY SUMMARY

There are four main types of machinery used in rice production. Most are used in some form in Japan, but only one or two might be in use in other Asian and Pacific countries.

Purposes of Mechanization

- Labor-saving devices primarily displace labor. They are intended to increase yields by ensuring that the crop is planted or harvested at optimal times.
- Machines such as mechanical sprayers and irrigation pumps directly increase yield because they carry out tasks that cannot be done the same way by hand.

Tractors (Land Preparation)

Use of tractors:

- saves time
- increases yields because they allow better timing of labor and mechanization

Attempts to develop large tractors based on a western model have been largely unsuccessful for a number of reasons:

- Most paddy rice in Asia grows in muddy areas where the wheels of tractors can't adhere.
- Small field size makes maneuvering difficult for large tractors.
- It is difficult to design machines for complex tasks.
- There is a lack of capital for purchasing equipment and an abundance of labor.
- Recent studies have shown that there is actually no increase in yields using tractors.

Smaller Scale Mechanization (Transplanting Machine, Combine-Harvester, Small-Scale Tiller)

Japan was the first to develop small to medium-sized mechanization. Primary Japanese machines are power-tillers, transplanting machines, and combine-harvesters. In Japan, these machines:

- have gained wide use and are labor-saving.
- do not cause the problems with displacing as much labor as larger methods of mechanization do.

These machines are used in other countries, but there are potential disadvantages:

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- Because most of these machines are imported from Japan, maintenance and repair are problems. Farmers must plan on allocating part of their operating budget for importing parts. Importers must have access to foreign currency.
- Terrain and other factors are different from Japan, and machines are not as well adapted to different situations.
- Financial backing depends on the form of government of the country.

INPUT SUMMARY

Without any inputs, wet-rice agriculture is distinct from other crops in that the fields tend to increase fertility over time rather than lose fertility due to the naturally occurring nitrogen-fixing algae in the water and the changes in chemical composition and soil structure due to rice production.

Different inputs to the maturing rice plants fall into two categories:

1. "traditional" inputs or processes that work best with traditional rice varieties (organic fertilizers such as animal manure, weeding);

   and

2. "chemical" or "modern" inputs which work best with HYVs (nitrate and phosphate fertilizers, chemical pesticides, herbicides).

Organic Fertilizers

Organic fertilizers have been used for centuries in rice production. They are generally cheap, readily available, and traditional rice varieties respond well to them (traditional rice varieties do not respond well to chemical fertilizers). Organic fertilizers used by most rice farmers include: compost, manure, and ashes from burning the rice stubble of the previous year's crop.

Chemical Fertilizers

Chemical fertilizers are critical components of the Green Revolution "package" and without them, HYVs often yield even less than traditional varieties. Chemical fertilizers such as nitrates and phosphates:

- enable HYVs to have extremely high rice yields
- are made by large chemical companies and can be expensive for small farmers (particularly because most developing countries must import them)
- have grown in use rapidly since the 1960s
- have a maximum level of efficiency after which returns begin to diminish, even under optimal conditions

Chemical Pesticides

Chemical pesticides prevent crop losses in cases where pests threaten the rice crop, so they do not directly increase yield. Because the specific pests and amount of threat they pose vary highly from one place to another and from one year to another, it is difficult to say with any certainty that they increase the overall rice yield. Because they are designed to kill organisms, pesticides also kill the natural organisms in the paddies (such as the nitrogen-fixing algae, snails, and small animals) and can also contaminate the water and soil, causing harm to both animals and humans.

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Chemical Herbicides

Chemical herbicides save labor on weeding and indirectly increase rice yield because weeds deprive rice plants of water and nutrients as well as harbor pests and diseases that threaten the rice. There is a danger of becoming dependent on these chemicals, which present some of the same problems as pesticides: ground water contamination, food chain amplification effects, soil damage, animal and microorganism mortality, health hazards to workers, and trace gas emissions. Growing interest in direct (or broadcast) seeding and a rise in labor costs have led to an increase in the use of herbicides as a substitute for human labor.

handout #4

RICE GROWTH AND PRODUCTION[1]

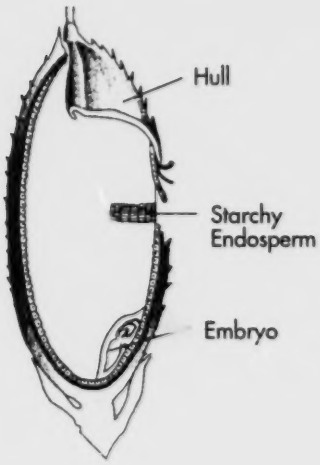
Rice, classified as a cereal grain, grows from a *semiaquatic* annual grass. As an annual, it must be replanted after each harvest except in rare, optimum conditions where it can continue to live for several years. There are well over 7,000 varieties of rice, and each may be best suited to grow in slightly different conditions. For the most part, however, rice thrives when grown in hot and humid environments. One of its most unique properties is that it grows best when its roots are submerged in water. The *morphology* of rice, or the biological study of its form and structure, helps explain characteristics like these. The vegetative, reproductive, and ripening stages of growth correspond closely to its morphology.

MORPHOLOGY AND GROWTH

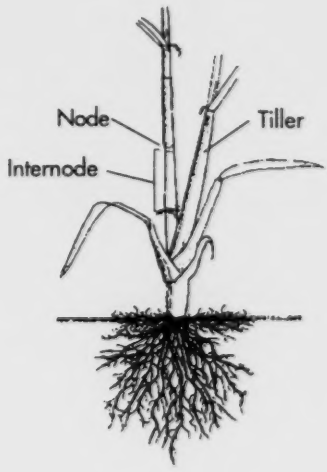
The Vegetative Stage

THE SEED. Because a grain of rice is milled before being eaten, it may not be obvious that it develops as a seed, just like a pea or bean. This seed, from which the plant grows, consists of a *hull* that encloses the true fruit, or brown rice. In turn, the brown rice contains the *embryo* and the *starchy endosperm, which* provides it with food for growth. It is this endosperm that is nutritious for human beings as well. In fact, the purpose of milling rice is to remove the outer layers that surround the brown rice. White rice, the most widely consumed rice product, requires additional milling to remove the embryo as well as the bran layer that gives brown rice its color. Grain length, width, and thickness vary widely for different varieties. A dried rice grain can weigh from 10 to 40 mg.

Cross-section of the rice grain



Parts of the rice stem and tillers



[1] adapted from "Rice growth and production," *IRRI Rice Almanac: 1993–1995.*

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THE SEEDLING. The seed is called a seedling when it has *germinated*, or sprouted. This occurs when the seed absorbs adequate water and is exposed to a favorable temperature, which can vary from 10 to 40° C. The root sprouts first unless air is scarce, in which case the young shoot develops until it reaches an aerated region. The seedling can also adapt to the absence of light if it is sown beneath the soil surface. A short stem will develop to lift the crown of the plant just below the surface, where normal growth will begin.

THE TILLERING PLANT. As soon as the seedling is self-supporting, the *tillering* stage begins, where the plant branches near the base into tillers that will eventually support the rice grains. *Tillers* consist of a series of *nodes* and *internodes* and accomplish the important task of extending the grains above the ground, which is usually flooded. In some deepwater varieties, the internodes can even lengthen by over 30 cm. to adapt to rising water. Similarly, the roots that develop mainly in the tillering stage vary their depth according to the amount of oxygen present in the soil. Before the tillering stage is over, the first, or primary tillers will often have branched into secondary and tertiary tillers.

The Reproductive Stage

THE PANICLE. Development of the *panicle* begins when all nodes on the tillers have been formed. The reproductive cycle and grain growth occur in this densely branched region. Along its small branches are the *spikelets* or florets, which contain the reproductive organs. Once the panicle elongates, the reproductive cycle begins. Flowering, or the opening of the floret for the purpose of *pollination*, may occur a few days after the panicle has emerged. Each floret contains a single egg, or *ovule*, which needs to be fertilized before a grain of rice can grow. Since rice is a self-pollinating cereal, pollination takes place before or as the floret opens, and there is less that 2 percent cross-pollination. All the spikelets in a panicle flower within a period of seven to ten days.

The Ripening Stage

THE RICE GRAIN. The rice grain begins to develop immediately following fertilization. In what is called the milk stage, which begins about three days after fertilization, starch grains start to appear. The *carbohydrates* that will be stored in the grain as starch are transported quickly through the plant to the developing seed. The three remaining stages, described as dough, yellow-ripe, and maturity, are characterized by an increase in the carbohydrate content and a decrease in the moisture content of the grain. The mature grain is ready for harvesting about 30 days after fertilization.

GROWING ENVIRONMENT AND PRODUCTION

General Requirements

Rice adapts easily to a number of climactic and soil conditions and can grow well on land unsuited to any other crop. It grows best, however, with average temperatures above 21° C (70° F) and an average rainfall of at least 1.1 meters (45 inches). Irrigation is therefore needed to supplement rainfall in areas such as the United States. In developing countries, rice requires a very large work force because it is transplanted, hoed, harvested, and processed by hand. But this process can also be highly mechanized to a point where human hands literally never touch the crop. Finally, most rice requires land to be physically structured so that a layer of water can be maintained or released as needed.

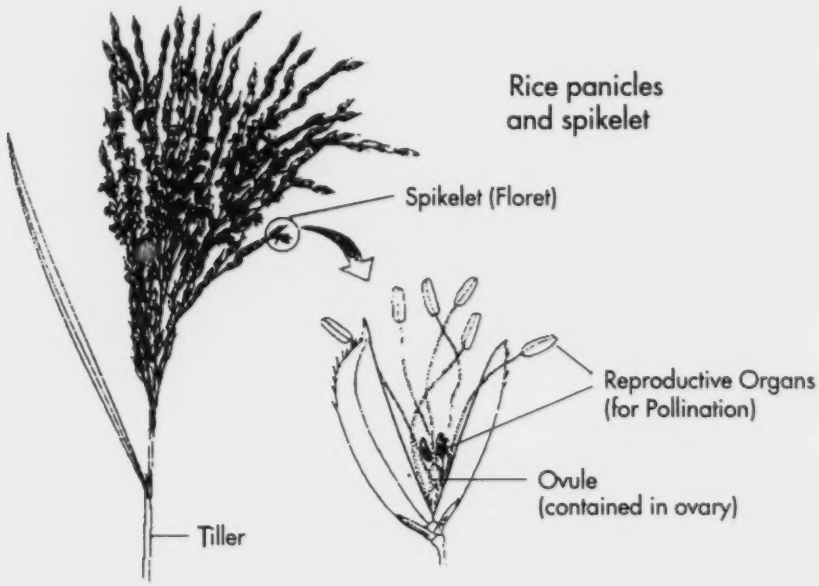
handout #4

Preparing the Land

WETLANDS AND UPLANDS. *Wetlands* are defined as having free water on their surface for most of the growing season. This may occur naturally in lowlands, but soil formed into raised *levees* may be used to restrain water as well. These dikes, usually 30 to 60 cm. (1 to 2 feet) tall and 1.2 to 1.6 meters (4 to 6 feet) wide, allow water to be added or drained as needed. Without sufficient rainfall, floodwater, or irrigation to grow wetland rice, *upland* rice must be grown. Its yield and quality are inferior because it depends on periodic rainfall for moisture and its soil is never submerged. Nevertheless, upland rice is profitable enough that a significant portion of the crop in South America, Africa, and Asia is produced in this way.

RICE SOILS. Rice production usually begins in the fall with preparation of the soil. Machinery is used to groom the soil until it is smooth and gently sloping. During the growing season, the slope allows for greater control of the irrigation or floodwater. This regulation is necessary because a favorable distribution of water stabilizes the chemistry of the soil, moderates the soil temperature, prevents soil erosion, and transports vital nutrients.

PLANTING. The rice seeds are sown in early spring. A grain drill can be used to place the seeds in narrow rows if the land is dry, or an airplane can be used to distribute the seed even if the land is wet. Often, seed that has already sprouted in a protective nursery is used for better results.



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Processing the Rice

HARVESTING AND DRYING. Water is drained from the fields when the rice reaches maturity. The rice is harvested either by hand or by machine up to two weeks later, after the moisture content of the grain has dropped to about 20 percent. Then the harvested rice is put through a further drying process using warm air to reduce the moisture level to about 12 percent. This process increases the storage life of the rice before milling.

MILLING. As mentioned before, the rice grain undergoes *milling* before it can be eaten. After being cleaned of dirt and other debris, abrasive forces remove successive layers of coating until the hull has been removed. What remains at this stage is known as brown rice, which is more flavorful and nutritious than white rice, but harder to store and slower to cook. White rice is obtained through additional abrasion. It is usually enriched with vitamins before being prepared into a final rice product.

A Glossary of Terms

CARBOHYDRATES:	simple sugars manufactured by the rice plant that are needed for the plant to grow; stored in the rice grain (seed) so it can develop before it is able to make its own carbohydrates
EMBRYO:	an organism in its earliest stages of development
ENDOSPERM:	inner tissue that provides the developing embryo with food for growth; also the part of the grain nutritious for human beings
GERMINATE:	to sprout
HULL:	the set of outer, protective layers of the rice grain, removed through milling
INTERNODE:	segment of a tiller capable of elongating in response to a high water level
LEVEES:	small dikes made from soil obtained from the fields in order to control the water level and water flow
MILLING:	a process that uses abrasive forces to remove layers from the rice grain
MORPHOLOGY:	the biological study of the form and structure of organisms
NODE:	a joint between segments (internodes) on the tiller
OVULE:	a minute structure that becomes the plant seed after fertilization; contained in the ovary
PANICLE:	the fairly dense and highly branched region at the end of tillers where the reproductive cycle occurs in the spikelets
POLLINATION:	transfer of pollen from the anther to the stigma of a plant to achieve fertilization
SEMIAQUATIC:	partly submerged in water
SPIKELET:	flower located in the panicle where the reproductive cycle occurs and the rice grain will eventually mature
TILLER:	a stem or branch on the rice plant that supports the panicle and rice grains

handout #4

TILLERING STAGE:	period of rice growth characterized by the development of tillers; begins when the seedling is self-supporting and ends upon panicle development
UPLAND:	land dependent on rainfall for moisture
WETLAND:	land having free water on its surface for at least the major part of the growing season

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Lesson 5

BIODIVERSITY IN RICE PRODUCTION

Organizing Questions

- What is biological diversity, and what roles does it play in rice production?
- How can we use our knowledge of biodiversity to improve the quality and quantity of food grown in Asia and the Pacific?
- How can we balance our need for increased food production with the need to preserve biodiversity on Earth?

Introduction

> Of all the dramatic changes that are of anthropogenic origin, the loss of biodiversity is the one that is most surely irreversible. Probably the best rough estimate is that by 2050, at least 10% of currently extant species will have become extinct. (Donald Kennedy, "Priorities for a 2050 World," Institute for International Studies, Stanford University, 1995.)

While the rapid human population growth on Earth creates a need for more and better food production, it also demands careful, sustainable resource use. Some of the environmental problems humans are wrestling with now come from an indiscriminate use and abuse of resources. If we continue to farm without replenishing the soil, irrigate without conserving water, and develop land without regard for the variety of species that live there, we may exhaust some of our resources before we have the chance to feed all the people. In our efforts to increase the production of rice, we must consider whether our methods will drastically and irreversibly affect the ecosystems of which we are a part. The variety of life, known as biodiversity, greatly affects and is affected by the processes of rice agriculture. Understanding how human activities affect biodiversity, and how this biodiversity affects our agricultural success, will help us develop sustainable agricultural methods to preserve the biodiversity and natural resources for the future.

This lesson consists of four parts in order to focus on biodiversity as a concept and then move gradually to how biodiversity plays a role in rice production. Part I is an introduction to biodiversity at its various levels. Students learn how genetic, species, and ecosystem diversity make up the overall diversity of any area by drawing a diagram of these levels for their chosen area. Part II looks at the biodiversity of rice agricultural ecosystems. Part III focuses on the concept of genetic diversity in rice species, allowing

students to analyze the specific traits that make up an improved rice plant. Part IV combines the concepts in the first three parts in that students analyze the biological, economic, agricultural, and environmental issues involved in rice agriculture as a monocrop compared to a multi- or polycrop system.

Objectives

knowledge

- to understand the meaning and role of biological diversity in the natural environment and in rice production
- to recognize the interconnectedness of all living things
- to distinguish between genetic, species, and ecosystem diversity in natural systems and rice agricultural systems
- to analyze the consequences of human decision-making and actions on biodiversity and the sustainability of rice production

attitude

- to appreciate the importance of biological diversity in natural ecosystems and in agriculture
- to consider the roles of technology and traditional agricultural systems in producing rice for an increasing human population

skill

- to communicate facts and views effectively
- to work with others in a group to solve problems
- to think critically about human activities and future decisions relating to biodiversity and rice production

Time

Part I: One class period
Part II: Two to three class periods
Part III: One class period
Part IV: Two to three class periods

Materials for Part I

- Three Levels of Biodiversity, overhead transparency
- Handout #1: Three Levels of Biodiversity Worksheet, one per student
- Biodiversity in My Life, pre-assessment, one per student
- Reasons for Conserving Biodiversity, overhead transparency

Materials for Part II

- 2 Rice Ecosystem Posters (irrigated and rainfed lowland ecosystems; upland and deepwater/flood-prone ecosystems)
- Handout #2, Relative Environmental Conditions, one per group

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Materials for Part III

- Super Rice cards, one set per group of nine students

Materials for Part IV

- 2 sets of Roles in the Rice Agricultural Ecosystem Cards
- butcher paper (1 meter square for each group)
- props for presentations

Procedure Part I

1. Introduce the concept of biological diversity to students by asking them to define the term *diversity*. They will probably refer to human diversity, to racial, cultural, or linguistic diversity in a population, defining it as the different kinds of people in a given area or population (the school, the city, the state, etc.). Explain that biodiversity is the same idea applied to all living things. ***Biological diversity (biodiversity)*** is the variety of all living things in nature, the ecological roles they perform, and the genetic variation they contain. Similar to the concept of human diversity, biodiversity is measured for a given area, from a square meter on the ground to the entire planet. We often compare the biodiversity of one area to another. For example, rain forests and coral reefs contain a lot of biodiversity, while grass pastures and sand dunes contain little biodiversity.

2. Use the overhead transparency, Three Levels of Biodiversity, to introduce and discuss the three levels of biodiversity. As you explain the definition of each level, have students quickly brainstorm a list of examples at each level. Several examples are provided on the overheads and handouts.

   A way to categorize these three levels is to explain that they range from the micro- to the macrolevel. The microlevel is the molecular level, called ***genetic diversity***. ***Species diversity*** is at the level of the whole organism. The macrolevel of biodiversity includes whole ecosystems, called ***ecosystem diversity***.

   Genetic diversity is the variety of traits within a species or population. Genes consist of DNA, which codes for all the traits of an organism, from hair color to leaf length. For any given trait, such as hair color, there are several variations of that trait in a species or population of a species. Members of the species could have brown hair, black hair, blonde hair, or red hair.

   Species diversity is the level referred to most commonly when discussing the biodiversity of an ecosystem. It is the number of different species (groups of organisms that are distinct from other groups) found in a given area. For example, a rain forest is considered to be one of the most biologically diverse

ecosystems on earth because of the incredibly large number of species found there.

Ecosystem diversity is the variety of different kinds of habitats in a given area. A habitat is an area defined by dominant physical characteristics such as temperature, humidity, and sun exposure. Habitats can be large areas, an entire such as whole rain forest in Indonesia, or small areas, such as the shady area created by a tree in a field.

3. Now have students practice their understanding of biodiversity at its three levels by filling in Handout #1, Three Levels of Biodiversity Worksheet, using an area of their choice. They may choose a local area whose plants and animals they know well or a far away location whose organisms they studied or would like to study. A diagram of a local area could include:

   Ecosystem diversity: parking lots, vacant lots, landscaped gardens, grass playing fields, protected parks

   Species diversity: within the landscaped garden ecosystem (e.g., tulips, daffodils, baby-tear ground cover, dandelions, ladybugs, slugs, snails, two different kinds of flowering bushes, mushrooms)

   Genetic diversity: within the ladybug species (e.g., red ladybugs, white ladybugs)

   You may want students to research different habitats and then share their findings with the class, thereby illustrating the diversity of ecosystems on the earth.

4. Next ask students: Why does it matter whether an area has a lot of biodiversity or not? An important facet of studying biodiversity in a realistic way is acknowledging the social, political, economic, and ethical contexts in which the science of conservation biology exists. In order to make this lesson relevant to students, and to assess how their attitudes change through the course of the lesson, give students the pre-assessment, Biodiversity in My Life. Now that they understand what biodiversity is, they can begin to clarify in their own minds if and why they value it. Allow about ten minutes for students to answer the questions on the pre-assessment, explaining that there are no right or wrong answers; they are merely expressing their opinions. Keep these pre-assessments to share and compare with students attitudes at the end of the lesson.

5. After students have turned in their pre-assessments, begin a discussion of if and why people value biodiversity. Use the questions on the pre-assessment to start the discussion. Questions 1-2 should help students decide what role other organisms play in their lives. Questions 2-3 address the idea of ecosystem services, such as microorganisms that rid the Earth

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of waste, and endangered species. Questions 4-5 refer to the aesthetic value of biodiversity, asking students to consider if they value simply "being in nature." Questions 6-7 address the economic value of species, helping students realize that something as seemingly removed as a rain forest actually provides them with many important items. Question 8 addresses the ethical reasons for valuing biodiversity.

Explain to students that on a purely biological level, it has been proven that ecosystems are more likely to survive environmental and human-induced changes over the long-term if they have a higher level of biodiversity; they have more variety from which to draw to adapt to changes in the environment. (More examples of this function of biodiversity will be discussed later in the lesson.) Scientists who study biodiversity and the way it affects the functioning of an ecosystem are called ***conservation biologists***. They assess the amount of biodiversity in an area and the status of organisms that may be endangered or threatened. However, this is all on a biological, non-value-laden basis. Conservation biologists are not necessarily environmentalists.

In addition to the biological benefits of the sustainability of an ecosystem, there are many other reasons humans value biodiversity. These reasons can be divided into four categories: Economic Benefits, Aesthetics, Ecosystem Services, and Ethics.

6. At this point in the discussion, write each category for valuing biodiversity on the board or overhead projector transparency. For each category, have students generate a list of their own values and experiences with wildlife as examples of that category. During this discussion of values and opinions, it is essential that you as the teacher do not promote your values over those of the students. The discussion will often be better if there are some conflicting opinions, but be sure to maintain a calm, respectful environment for students to express their values openly. Conclude the discussion, by discussing in detail the four categories, using the transparency, Reasons for Conserving Biodiversity.

   Economic Benefits: Humans benefit from wild plants, animals, and microorganisms for food, medicines, clothes, fuel, and other items. We breed our domestic plants and animals to their wild relatives to improve the genetic stock and take advantage of traits that the wild relatives have. Twenty-five percent of the pharmaceuticals we use come from the rich biodiversity of the rain forests. Furthermore, the business of ecotourism takes advantage of the fact that people will pay to see wildlife by bringing people to areas with a lot of biodiversity. Developing countries especially are using this economic boost to capitalize on the value of biodiversity.

Aesthetics: Ecotourism provides not only an example of the economic benefit of biodiversity, but it also demonstrates how humans derive unquantifiable benefits from wildlife; we appreciate the beauty and wonder in nature. Many people value the peace and companionship they receive from simply being in nature and knowing that wild places exist. The number of bird-watchers, campers, hikers, and parks and preserves gives evidence of the aesthetic value of wildlife and biodiversity.

Ecosystem Services: Humans depend on functioning ecosystems for the "services" they provide. Water in rivers and streams is clean because forests and fields prevent erosion. Air is clean because plants filter out much of the pollutants. Plants and microorganisms put nutrients back into the soil that other growing plants use up. Natural ecosystems control pests and diseases and recycle wastes and nutrients. Healthy ecosystems also sustain species diversity. Species depend on one another, so if one species is removed, other species on which we directly depend are likely to be lost.

Ethics: This is the only reason for valuing biodiversity that is not human-centered; it has a moral basis rather than a pragmatic one. Many people believe that all organisms, from the smallest slug to human beings to oak trees, have a right to live and grow. There does not need to be an economic or psychological benefit for humans to justify the existence of an organism.

Explain to students that the amount of biodiversity in an area can vary greatly in both natural ecosystems and agricultural ecosystems. Generally, when humans disturb a natural ecosystem, they decrease the amount of biodiversity in that area. For example, when humans cut down a rain forest or fill in a wetland and build houses on the land, the amount of species diversity is reduced. However, when humans construct an agricultural ecosystem (agroecosystem), they can either increase or decrease the amount of biodiversity at all three levels of diversity.

Ask students how the amount of genetic diversity, species diversity, and ecosystem diversity affect human activities and our ability to produce enough quality food for a growing population. And how do human activities affect the diversity of natural and rice ecosystems in our attempt to improve rice production? In the next activity, students closely examine the various levels of biodiversity involved in rice agriculture.

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Procedure Part II

In this part of the lesson, students will explore ecosystem diversity in rice agriculture. They will first look at the ecosystem level, analyzing the environmental characteristics of the most common rice ecosystems and matching them to photographs on posters depicting each ecosystem.

1. Begin by reviewing the definition and examples of the three levels of biodiversity. Discuss how we can apply these organizational levels to rice agriculture. Write the three levels as headings on the chalkboard or overhead projector transparency and ask students to suggest examples for each level of diversity as it applies to rice ecosystems.
   - Genetic diversity refers to the traits of a particular rice species that could vary from plant to plant. For example, some plants may have longer stalks and others shorter stalks, some may have more seeds per stalk than others, some may be more resistant to flood or fungal diseases than others, etc.
   - Species diversity refers to the different kinds of rice species as well as of plants and organisms found in a specific rice ecosystem, either traditional or monocropped. For example, one might find several species of fish, microorganisms in the water, one or more species of rice, several species of shellfish, flying insects, water insects, many species of plants other than rice, etc.
   - Ecosystem diversity refers to the different habitats or climates in which rice would grow well. In an area that may be conducive to growing rice, such as Indonesia, there are other ecosystems as well, such as Southeast Asian rain forests, marshlands, rice paddies, river and stream ecosystems, human inhabited ecosystems, etc.
2. Once you finish generating the list for the three levels of biodiversity, divide students into groups of 3 or 4 . Ask students what kinds of environmental conditions would define a rice ecosystem. What climate characteristics would be beneficial for rice farming? Using the 2 Rice Ecosystem Posters, assign each group to identify one of the four rice ecosystems. Give each group a copy of Handout #2, Environmental Conditions Resource Sheet which contains information about the possible environmental characteristics of each rice ecosystem. Have students analyze the ecosystem and determine which of the environmental characteristics applies to the system. On a separate piece of paper, have the group:
   - Define their ecosystem as either an upland rice ecosystem, a rainfed lowland rice ecosystem, a deepwater/flood-prone rice ecosystem, or an irrigated rice ecosystem.
   - List the environmental characteristics of their ecosystem.

- Describe at least three agricultural and/or technological strategies humans might need to use in order to grow rice efficiently in this ecosystem. Consider that humans have to adapt to the environmental conditions of the area, such as rainfall, elevation, topography, flooding, heat, and humidity.

You may suggest agricultural and technological strategies such as handpicking versus using a combine, using a boat to tend or harvest rice because floodwaters are so high, using engineered drainage systems, or developing machines that work under water. Students' answers can be creative but should be realistic.

3. Have students present their conclusions to the class. Then have them explain the strategies they decided humans would need to use to adapt to the environmental conditions of that ecosystem.

Procedure Part III

Now that students have explored the ecosystem diversity of rice agriculture and the associated affects on agriculture, they can focus on a topic of much political, economic, and scientific debate: genetic diversity in rice agriculture. The rapidly developing field of genetic engineering is resulting in a barrage of questions about the environmental, economic, and even ethical consequences of manipulating the genes of other species for human uses. This activity allows students to work with some of the specific genetic traits in rice in order to create an improved rice species, the Super Rice. A basic knowledge of genes and how they code for physical traits is recommended, but not required. You may want to use this activity as a jumping-off point for the study of Mendelian genetics, genetic engineering, and the current methods of breeding wild relatives of domestic stock to improve existing crops.

1. Make one copy of the Super Rice Card Sheet for each group of nine students, and cut the cards apart.
2. Review with students the definition of a *gene* (the code for a specific trait in an organism), and clarify the term *trait*, the observable characteristic in an organism. Ask students to brainstorm a list of traits they have, such as brown eyes, brown hair, double joints, a dimple on the chin. Then ask them to brainstorm traits a plant might have, such as leaf length, number of leaves, number of stalks, drought resistance, or pest resistance.
3. Now ask students: Why would genetic diversity be important in rice agriculture?
   - More variations in the traits of rice species allows rice to grow in many different climates, habitats, and locations. For example, one species of rice grows well in lowland flooded

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areas, while another grows well in upland areas, two very different ecosystems.

- Variation in the traits of one rice species means that the species is less likely to be wiped out by disease or natural disasters. If one variety of the plant is killed by a blight, but there is a variety that is resistant to the blight, then the crop may recover due to the resistant plant. If there was no resistant variety, then the entire crop would succumb to the blight.
- Humans have learned to breed domestic plants to their wild relatives in order to produce plants with preferred traits.

4 Present the following to students: There are about 20 different rice species in the world, but only two are used extensively by humans. Why is this? What would be the benefit of having only a few kinds of rice with very specific traits planted all over a large area? What would be the disadvantages of this?

5. To introduce the activity, ask students to imagine they are rice farmers. If they could choose any characteristics they wanted their rice to have, what would they choose and why? Would they want taller stalks that would be easier to harvest in the water, or shorter stalks that wouldn't blow over in the wind? Would they want more rice seeds per stalk so it would reproduce faster, or less seeds so they wouldn't weigh down the stalk? With the technology available in genetic engineering, this type of question is almost realistic to ask. As long as the gene exists for the desired trait, scientists can splice that gene into the plant in question, producing a "perfect" rice plant, a Super Rice.

6. Divide students into groups of nine and distribute one set of Super Rice Cards to each group, one card per student. Make sure students do not show their cards to anyone else in their group.

7. Each student has information on the traits, sources, and/or reason for an improved rice trait in Super Rice. The three questions students are to answer are also included on one of the cards. Without showing their cards to anyone else, students as a group must discover and answer the questions:

   - What traits make up Super Rice?
   - How do we create it?
   - What makes it better than other rice?

   This activity will not only force students to practice their communication skills, it also forces them to consider their information and rephrase it in their own words, allowing better internalization of the content. Allow students 20 to 25 minutes

to work out the problem and match the traits, sources, and rationales.

8. Ask groups to share their results with the rest of the class, writing the results on the board as the groups describe them. Use the following key to verify their answers:

Trait	How is it created?	Why is it better?
Short, sturdy stalks	Wild rice	Won't break in wind
More panicles per stalk	Biotechnology, from IRRI germ bank	More rice per plant
Fewer stalks	Biotechnology, from IRRI germ bank	More rice per plant
Shorter growth period	Plant breeding with other species	More crops per year
Resistance to pests	Oryza officinalis (species of rice)	Able to resist pests
Resistance to disease	Genetic engineering	Able to resist disease

9. Discuss the role of Super Rice in the process of rice production and in the context of the technologies explored in lesson 4, revisiting the questions students answered earlier in this activity:

   - How might Super Rice aid us in growing enough rice for the world?
   - What are some negative consequences of planting one kind of rice, no matter how "super" it is, over a large area?

   Remind students of the trade-offs of technologies such as the necessity of fertilizers, issues of affordability, and cultural uses of rice.

10. Referring to the list and your discussion of why genetic diversity is important in rice production in Asia and the Pacific, ask these extension questions:

    - What are the threats to genetic diversity in rice?
    - What kinds of strategies might we use to ensure that we preserve this genetic diversity?

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Procedure Part IV

This final activity brings together the topics covered in the rest of the lesson—species diversity, genetic diversity, and rice as a food source—as well as issues from previous lessons involving technology inputs in rice agriculture. Students will analyze the positive and negative effects of choosing one of two rice-growing methods: the *polycropping* method using traditional seeds, or the modern *monocropping* method using Super Rice seeds. Polycropping typically means farming more than one crop, either on a given plot of land (intercropping) or within an agroecosystem. Monocropping typically means the farming of a single crop in an agroecosystem over time.

1. Ask students to picture a rice farm in their minds. Using the chalkboard or overhead projector, brainstorm a list of answers to the following two questions: What plants and animals do they imagine living there, either domestic or wild? What amount of species diversity, or number of different kinds of species, do they imagine in the rice agricultural ecosystem, as compared to other ecosystems? Explain that the amount of species diversity in a rice farm depends on the methods of farming that a particular farmer chooses to use. In this activity, students will have a chance to see the problems farmers face in choosing their methods of rice agriculture, as well as the solutions they can choose from.

2. So that students can evaluate the effects of each kind of rice agricultural system, review with students what they learned about genetic diversity in rice in the Super Rice activity.

3. To begin the activity, separate out one-fifth of the class and make these students the "neutral group." This group will represent a rice research and consulting team. Divide the rest of the class in half. One half will represent Rice Farm A, the other half will represent Rice Farm B.

4. Distribute one set of Roles in the Rice Agricultural Ecosystem Cards to each farm, one to each student, and ask students to read their cards carefully. Some of the cards have human roles for students to play, some have other species' roles, and some have roles as resources (water, soil). One card in each farm will designate one person as the "farmer."

5. Ask the students who received the farmer cards to step forward. They need to decide which of the two agricultural methods they will use for their farm: either the traditional rice seeds and polycropping methods, or the modern Super Rice seeds and monocropping methods. Each kind of farm needs to be modeled, so if they can't choose, flip a coin.

6. The rest of the students must now decide how their farm would be affected by their farmer's choice. For example:

- Deciding to use high yield varieties (HYV) or Super Rice in a monocrop system rather than a traditional polycrop system might result in less genetic diversity in the crop, more fertilizer use, more pesticide use, and therefore the death of beneficial insects. The outcome might be fewer pests and more rice, which means more people are fed.
- Deciding to use a traditional polycrop system instead of a HYV or Super Rice in a monocrop system might result in more pests and less rice, but more snails and fish and other plants that humans can eat.

7. The task will be for each student to contribute to three products during the activity:
   - First, have each students individually write a brief description (one paragraph) about how the organism, person, or resource they represent would be affected by their farmer's choice of monocropping or polycropping methods. This will help students contribute to their group's discussion.
   - As a group, each farm must produce a drawing, flow-chart, or schematic (on a piece of butcher paper) of how each of its members would be affected, how much input of fertilizers and pesticides there would be, how much rice would be produced, what amount of other food sources would be produced, etc., all in comparison to the other type of farm.
   - As a group, each farm must produce a presentation for the rice research and consulting team on the costs and benefits, or pros and cons, of their farming methods. They must focus on: a) how the biodiversity of their farm ecosystem is affected, and b) how the people who rely on the farm for food are affected. Encourage them to be creative in their presentation; it could take the form of a docudrama, interviewing each of the inhabitants of the system, a fairy tale telling the story of the farm, or another dramatic format. (They may use their groups' drawing or schematic as a visual aid for their presentation.)
   - Groupwork Suggestions: In order to avoid a massive group of students in one conversation, suggest that students get into smaller groups according to the categories, "humans," "other species," and "resources." The farmer can circulate throughout his/her farm, finding out how his/her decision is affecting the farm. You may also suggest that members of the two farms talk to each other to compare the pros and cons of each method, for example, "humans" from Farm A could talk to "humans" from Farm B, etc.
8. The rice research and consulting team will be choosing one of these methods of farming to recommend as the preferred method for rice production in Asia and the Pacific. They

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should therefore circulate among the discussion groups, listening but not participating in the discussion, taking notes on the effects of both methods of farming. The members of this group should also discuss among themselves the pros and cons of each farming method, so they will be prepared to make a decision as soon as the presentations are completed.

9. Have each farm group give its presentation. Allow the rice research and consulting team about 5 minutes of discussion to decide on a recommendation. Then instruct the rice research and consulting team to give a brief presentation of what they will recommend and why, outlining the advantages and disadvantages of their decision.

10. As a follow-up discussion, ask students what it felt like to represent a specific animal, plant, resource, or person. In addition, were there things that one group thought of that another group left out?

11. Explain to students that these two methods of farming represent the two extremes of the issue of monocropping versus polycropping. Farmers and scientists are currently trying to find ways to combine the best parts of both systems. Ask students to brainstorm their own solutions to this dilemma. What might a "combination" farm look like? What are the difficulties, both social and technical, involved in creating such a combination system?

12. Distribute the student responses to the pre-assessment, Biodiversity in My Life. Now that students have completed lesson 5, ask them the following closing questions: Would you answer any of the questions on the pre-assessment differently now? What are the roles of the different levels of biodiversity in rice agriculture? How is biodiversity connected to our ability to use plant technology as well as more traditional systems? Why is biodiversity an important factor to consider in our efforts to grow enough food for everyone in Asia and the Pacific both now, in the short-term future, and in the long-term future?

transparency

THREE LEVELS OF BIODIVERSITY

Genetic Diversity

Genetic diversity is the variety of traits within a species or population.

- Genes consist of DNA, which codes for all the traits of an organism such as hair color to leaf length.
- For any given trait, such as hair color, there are several variations of that trait in a species or population of a species. Members of the species could have brown hair, black hair, blonde hair, or red hair.

Species Diversity

Species diversity is the number of different species (groups of organisms that are distinct from other groups) found in a given area.

- A species is a group of organisms that is distinct from other groups and cannot breed with members of other groups.
- For example, a rain forest is considered to be one of the most biologically diverse ecosystems on earth because of the incredibly large number of species found there.

Ecosystem Diversity

Ecosystem diversity is the variety of different kinds of habitats in a given area.

- A habitat is an area defined by dominant physical characteristics such as temperature, humidity, and sun exposure.
- Habitats can be large areas, such as an entire whole rain forest habitat in Indonesia, or small areas, such as the shady area created by a tree in a field.

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THREE LEVELS OF BIODIVERSITY WORKSHEET

Genetic Diversity

Genetic diversity is the variety of traits within a species or population.

Species Diversity

Species diversity is the number of different species (groups of organisms that are distinct from other groups) found in a given area.

Ecosystem Diversity

Ecosystem diversity is the variety of different kinds of habitats in a given area.

BIODIVERSITY IN MY LIFE

1. Name five objects in your classroom that come from a plant or animal.

2. What would happen if there were no microorganisms on Earth to decompose dead things and waste?

3. If a farmer in your area wanted to begin plowing a field that contained a population of an endangered fox, would you be for or against it? Why?

   If it was an endangered plant instead of a fox, would you be for or against it? Why?

   Would your arguments change if, instead of a farmer, it was a real estate developer wanting to build condominiums? Why or why not?

4. Do you ever go for a walk or visit a natural place, like a park, a lake, or forest? Do you ever go camping or hiking?

5. How would your life be different if you could no longer go for walks, hikes, or otherwise "get out into nature?" Would it be significant loss? Why or why not?

6. How would your life be different if you could not use medicines or other drugs? Did you know that 25 percent of all pharmaceuticals come from the rain forest?

7. How would your life be different if you could not have coffee, chocolate, bananas, tropical hardwoods, rubber, xantham gum (used in ice cream)? (These are all products of the rain forest.)

8. Do you believe animals and plants have a right to exist regardless of any benefit to humans? Why or why not?

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Reasons for Conserving Biodiversity

Economic Benefits

Humans benefit from wild plants, animals, and microorganisms for food, medicines, clothes, fuel, and other items. We breed our domestic plants and animals to their wild relatives to improve the genetic stock and take advantage of traits that the wild relatives have. Twenty-five percent of the pharmaceuticals we use come from the rich biodiversity of the rain forests. Furthermore, the business of ecotourism takes advantage of the fact that people will pay to see wildlife by bringing people to areas with a lot of biodiversity. Developing countries especially are using this economic boost to capitalize on the value of biodiversity.

Aesthetics

Ecotourism provides not only an example of the economic benefit of biodiversity, but it also demonstrates how humans derive unquantifiable benefits from wildlife; we appreciate the beauty and wonder in nature. Many people value the peace and companionship they receive from simply being in nature and knowing that wild places exist. The number of bird-watchers, campers, hikers, and parks and preserves gives evidence of the aesthetic value of wildlife and biodiversity.

Ecosystem Services

Humans depend on functioning ecosystems for the "services" they provide. Water in rivers and streams is clean because forests and fields prevent erosion. Air is clean because plants filter out much of the pollutants. Plants and microorganisms put nutrients back into the soil that other growing plants use up. Natural ecosystems control pests and diseases and recycle wastes and nutrients. Healthy ecosystems also sustain species diversity. Species depend on one another, so if one species is removed, other species on which we directly depend are likely to be lost.

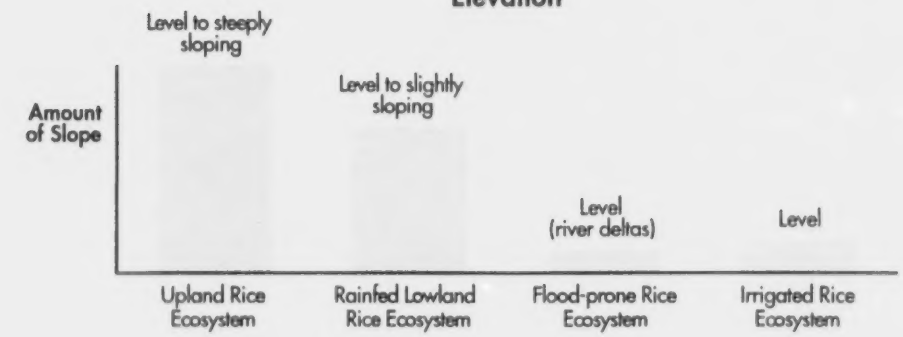
Ethics

This is the only reason for valuing biodiversity that is not human-centered; it has a moral basis rather than a pragmatic one. Many people believe that all organisms, from the smallest slug to human beings to oak trees, have a right to live and grow. There does not need to be an economic or psychological benefit for humans to justify the existence of an organism.

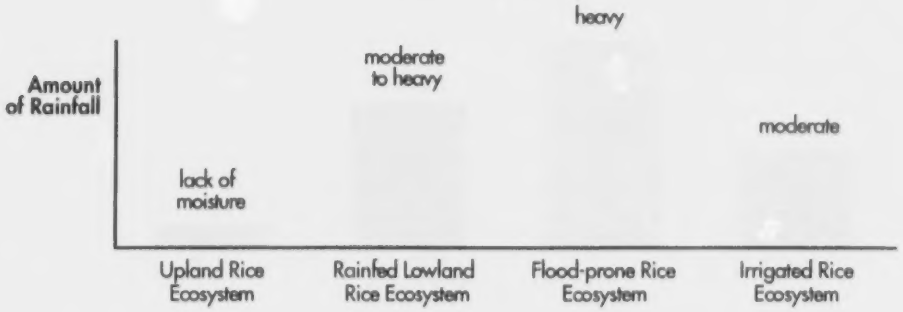
handout #2

RELATIVE ENVIRONMENTAL CONDITIONS

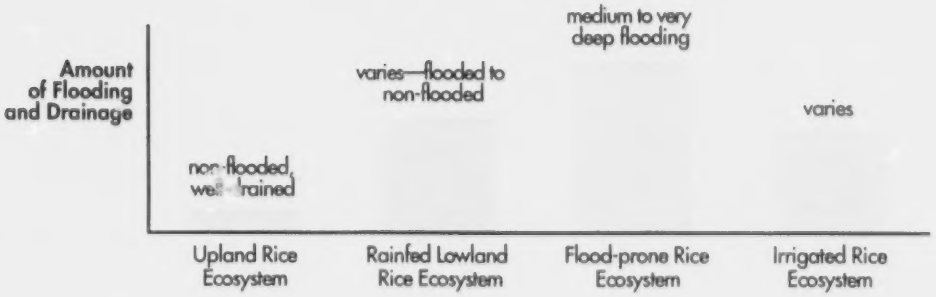
Elevation



Rainfall Patterns



Depth of Flooding and Drainage



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SUPER RICE CARDS

The environment is monsoon Asia. Most rice plants today have 20-25 stalks, but only 15-16 of them produce panicles.	Tall stalks break easily in the wind. Biotechnology using other rice species can increase the number of stalks that produce panicles.	Some wild rices have short, sturdy stalks. Scientists know which genes in a rice species can resist diseases.
A monsoon can bring heavy rain and winds. There are 80,000 rice seed samples in cold storage at IRRI's Genetic Resource Center.	More panicles, or heads of seed, on the plant mean more rice that can be harvested. Blast and bacterial blight are diseases that threaten rice crops.	Too many panicles on a plant make the stalks fall over. Scientists can use seed samples from different rice species to breed plants to grow faster.
Oryza officinalis makes rice less palatable to hoppers. Shorter growth period in rice plants means more crops can be planted in a given year.	Stem borers and leafhoppers attack rice plants and spread disease. A smaller number of stalks makes it easier for the rice plant to produce more panicles.	Cultivated rice is *Oryza sativa*. Other wild rices share the same generic name, *Oryza*, but have different species names. What traits make up Super-Rice, how do we create it, and what makes it better than other rice?

ROLES IN THE RICE AGRICULTURAL ECOSYSTEM

Rice grows best with uncontaminated water, benefits from rich soil, is tended by rice field workers, and can be harmed by some Insects and diseases; productivity of rice crop enhanced by pesticides and fertilizers	**Fish** fertilize soils; killed by pesticides; eat wild plants that compete with rice plants for resources; provide food for some birds and humans
Rice Farm Owner makes decisions about whether to use traditional rice farming methods or high yield varieties (like Super Rice) and modern farming methods; depends on rice crop for livelihood	**Birds** live and nest in taller rice plants and wild plants or nearby trees; feed on insects, snails and small fish; eventually killed by pesticides found in food sources
Soil enriched by chemical fertilizers, bacteria, and by natural fertilizers such as fish and other animal's manure	**Human Rice Consumer** depends heavily on rice crop for survival; buys rice in large quantities; also can eat snails, fish, other crop plants, products from trees
Bacteria lives naturally in the soil; some kinds of bacteria enhance soil quality; killed by pesticides	**Insects** Some insects, such as leafhoppers and stem borers, eat rice plants and spread disease; killed by pesticides; Super Rice is resistant to some insect pests; eaten by fish and frogs
Rodents such as rats, eat the rice plants; Super Rice is not resistant to rodent pests	**Water** contaminated by pesticides; provides a home for fish, snails, frogs; necessary for rice plants and wild plants and other crop plants to grow
Rice Field Worker plants, weeds, irrigates, fertilizes, harvests rice plants; harmed by pesticides; depends on rice crop for livelihood	**Snails** eat all plants; killed by pesticides; provide food for some birds and humans (good source of protein)
Frogs eat insects; naturally fertilize the soil; killed by pesticides	**Trees** provide shade so water in rice fields doesn't evaporate quickly; provide homes for birds; can provide products for humans to eat or sell
Wild Plants provide food for fish, snails, insects, birds; compete with rice for resources in soil and water	**Other Crop Plants** compete with rice plants for soil, water; provide more variety so less chance of total crop failure; may draw pests; provide food for humans, insects, fish, birds

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Lesson 6

RICE POLICY AND THE STAGES OF AGRICULTURAL DEVELOPMENT

Organizing Questions

- What impact does policy have on rice production in Asia and the Pacific?
- How is policy concerning rice production affected by the stage of agricultural development in which a country exists? What are the three stages of agricultural development and in which stage does each of the Asian rice producing countries exist?
- What are some major current policy issues that are affecting rice in Asia?

Introduction

> In searching for the causes of hunger, it must be recognized that hunger is not a disease or a single biological state, but an individual problem caused by inadequate food intake. For purposes of food policy, which deals with the decisions made by food consumers and producers, inadequate food intake is defined relative to the individual's own perception of the food needed to maintain good health, provide for growth, and allow a choice of physical activity levels, including work levels. (Peter Timmer, Walter Falcon, and Scott Pearson, "Introduction to Food Policy Analysis," in *Food Policy Analysis*, p. 6.)

Because hunger is an individual problem, and is governed by the individual perceptions of food consumers and producers, it is difficult for food policymakers to implement overarching policies across large areas. In order for policy discussions to go smoothly within and between nations, policymakers have identified certain stages of agricultural development, which place nations with similar characteristics into a particular stage. These characteristics reflect the changes in the importance of agriculture as each country develops. Issues of increasing population, decreasing amounts of available rice land, and growing environmental concerns must be considered very carefully in making policies regarding rice production. Policies must help develop new technologies, promote efficiency, and improve agricultural output. Depending on the current situation in a particular country, policies will target price levels, public investment, and use of available resources. These policies affect farmers, the urban population, politicians, and trade representatives in different ways.

In this lesson, students will learn about three stages of agricultural development and how these stages relate to the six rice-producing

countries they've studied in this unit. Please note that this is just one model of looking at agricultural development. Students will work in pairs to generate characteristics of comparison between the three stages of agricultural development. They will then apply the vocabulary and concepts of economics and policy to a personal and individual level by answering questions to help them clarify their values concerning money and lifestyle. Finally, students will be divided into their six country groups and re-examine population and economic information about their country. As "policy experts," students will develop a presentation of their policies and recommendations in preparation for the upcoming International Rice Summit in lesson 7.

Objectives

knowledge

- to understand that many political, economic, and environmental factors must be considered in order to make effective policy decisions
- to learn about the three stages of agricultural development and the characteristics associated with each stage
- to learn about some major current policies pertaining to rice production and current issues affecting international rice policy

attitude

- to examine current trends in the world rice market and develop an appreciation for the differences that exist between various Asian countries
- to understand how environmental issues have a strong impact on rice economies and policy decisions
- to examine how the opinions and perspectives of many different people must be carefully considered before creating rice policy

skill

- to analyze graphs, tables, and other statistical information pertaining to rice production in Asia
- to discuss policy issues within a small group with an understanding of certain economic and environmental conditions
- to share opinions and information about rice policy in Asia in preparation for the International Rice Summit (Lesson 7)

Materials

- Handout #1: Stages of Agricultural Development, overhead transparency and one copy for each pair of students
- Handout #2: Stages of Agricultural Development Organizer, one for each pair of students
- Handout #3: Vocabulary, one per student
- Handout #4: Stages of Agricultural Development Questions, one per person

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- Handout #5: Country Presentation Instructions, one per group
- Country Information Sheets from Lesson 1: Bangladesh, China, Indonesia, the Philippines, Japan, Thailand; one set
- Stages of Agricultural Development Organizer, Answer Key, for the teacher

As countries develop, there is a gradual change in focus from agricultural production to industrialization. In the agricultural development model introduced in this lesson, there are three stages of agriculture that occur during this transition, and government policy towards agriculture shifts focus in each stage. This change in policy is due to the fact that the importance of agriculture changes as a country develops.

First Stage: In the first stage, most resources are in the rural areas, and most people earn their living through agriculture. Government policies during this stage tend to focus on improving a country's infrastructure, obtaining new technology, and maintaining political stability. The goal of policy is usually toward increasing agricultural output. Today, many Third World countries are still in this first stage, and it is here that poverty is a major problem.

Second Stage: In the second stage, the countries are starting to industrialize, and policy needs to focus on maintaining a balance between agriculture and industry. Increased agricultural output is necessary to sustain the growing urban population. This stage is typified by a "resource squeeze" between new urban industries and a strong agricultural sector.

Third Stage: In the third stage, countries have reached the high end of their development, and agricultural production is a smaller percentage of their total output. However, policy must focus on protecting agriculture to help maintain equitable income distribution for members of the rural population. Currently, much of the trade friction involving agriculture is centered on countries in this last stage.

Procedure

1. Begin the lesson by asking students the following questions and brainstorming some answers, writing their responses on the board or an overhead projector transparency. These will give some context to the lesson and help you assess how much your students already know:
   - How do you think the agricultural practices and food production of a country would affect the economics of that country?
   - How do you think agriculture might affect trade policies and international relations between countries?

- How might agriculture then affect the development of a country?
- How do you think all of these things affect domestic policies?
- Based on what you know about the rice-producing countries of Bangladesh, China, Indonesia, Thailand, Japan, and the Philippines, what stage of agricultural development do you think each of these countries is in?

2. After this brainstorming session, explain that as a country develops, there is a gradual change from agricultural production to industrialization. There are three stages of agricultural development that occur as a country makes this change to industrialization. Governments must make many important decisions related to agriculture and consider issues of increasing population, decreasing available land supply, and growing environmental concerns. As governments make their decisions, they must also consider the variety of people being affected by agriculture, including farmers, the urban population, politicians, and those involved with international trade.

3. Divide students into pairs. Use Handout #1, Stages of Agricultural Development, and its transparency, to discuss the common characteristics of countries within each stage. Distribute a copy of this handout as well as Handout #2, Stages of Agricultural Development Organizer, and Handout #3, Vocabulary, to each pair of students. Instruct students to use this information to organize the characteristics of each of the stages of agricultural development on Handout #2, Stages of Agricultural Development Organizer. If needed, supplement their information with your own explanations from the Teacher Background information above, and discuss any of the vocabulary words students don't understand.

4. Now that students have some working knowledge of the concepts and terms used when discussing agricultural development, it is important for them to realize how these abstract policies and situations affect the average person living in a rice-growing country. Discuss with students terms such as *income per capita*, *subsistence level* and other phrases found in Handout #3, Vocabulary, on a personal and individual level. This is essential to helping students see just what it means to be an average citizen of a country in a particular stage of development.

   To accomplish this more personal level of understanding, distribute Handout #4, Stages of Agricultural Development Questions. These questions will help students analyze the theoretical information and connect it to their own lives and experiences. Give students about 20–30 minutes to answer

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these questions, working in groups if they choose to. Remind them that their answers should represent their own opinions. When they have finished, review the questions as a class to compare their answers.

- How did their lists of "necessary" items change according to the stage of development they imagined themselves in?
- How would they imagine their futures to be if they were living in countries in different stages of development?

5. Divide students into six groups to represent each rice-producing country: Japan, Indonesia, China, Bangladesh, Thailand, and the Philippines. Give each group a copy of Handout #5, Country Presentation Instructions, and their appropriate Country Information Sheet (from lesson 1). Tell students that each group has been chosen to represent its country at the International Rice Summit (IRS) in lesson 7, and they must become experts on their country's agricultural development issues. They must prepare a presentation using visual aids (posters, charts and graphs, props) to introduce themselves to the other IRS nations. The presentation must include an introduction to their country, its challenges, possible solutions, and policy regarding agriculture. Allow students to use half of one period and outside-of-class time to prepare their presentations.

handout #1

STAGES OF AGRICULTURAL DEVELOPMENT

Agriculture is the initial base from which a country grows. Issues involving food prices, land prices, agricultural production, farmer income, and land use are important to the success of a country in each stage of agricultural development.

In analyzing the following information, consider the similarities and differences of each stage of development, as well as concrete examples from countries around the world. Then use this information to complete Handout #2, Stages of Agricultural Development Organizer, and Handout #4, Stages of Agricultural Development Questions.

Stage I

For a country in Stage I, most of the resources are in the rural areas, and most people earn their living through agriculture. Government policies during this stage tend to focus on improving a country's infrastructure, obtaining new technology, and maintaining political stability. The goal of policy is usually towards increasing agricultural output. Today, many "Third World" countries are still in this first stage, and it is here that poverty is a major problem.

Extreme poverty exists in Stage I countries. The per capita income range for these Stage I countries is $100 to $500 per year. In these poorer countries, farmers struggle to feed their families. Often these farmers are using old, inefficient equipment and technologies. They have difficulty bringing sufficient water to their fields, and often don't have the information they need to improve production.

Just as the citizens of a Stage I country are often poor, so is its government. To help these countries pay off their debt, many Stage III countries have offered millions of dollars in aid to most of these Stage I countries.

Stage II

Countries in Stage II begin industrializing, and their policies need to focus on maintaining the balance between agriculture and industry. In Stage, II, countries have developed a strong agricultural base, but there is now a shift towards industry and manufacturing. As cities grow and huge factories are built, agriculture remains very important but faces new problems. This stage is typified by a "resource squeeze" between new urban industries and a strong agricultural sector.

Countries in Stage II typically have an income per capita range of $500 to $4,000 per year. Typically, with people in the city earning more money, there is an increasing pressure on government to help farmers. As the demand for agriculture goes up while the numbers of farmers decline, prices will obviously rise. The real dilemma for government in this stage is how to maintain balanced growth between agriculture and industry.

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As income rises, people include more meat in their diets. Of course, cattle feed on grain, causing a need for increased agricultural production. Therefore, in addition to increased demand caused by an increasing population, there is an indirect demand on agriculture caused by people's changing eating habits. One result of this is that countries need to import rice.

Stage III

Stage III countries have reached the high end of their development, and usually have large, successful economies. Agricultural production is a smaller percentage of their total output. However, policy must focus on protecting agriculture to help maintain equitable income distribution for members of the rural population. Currently, much of the trade friction involving agriculture is centered on countries in this last stage.

The average income per capita in this stage is in the range of $4,000 to $25,000 per year. In Stage III, countries have well-developed agricultural and industrial sectors, poverty is less of an issue, and infrastructure is solid. As cities grow, they take over large areas of land once used for agriculture, resulting in a sharp increase in the price of land in countries such as Japan. Prices of agricultural goods must rise along with the price of land so that farmers are able to support themselves.

Often in Stage III countries the agricultural sector is inefficient and needs to be supported by the government. During this stage, governments often use subsidies to keep the price of agricultural goods stable and to keep the farmers happy. Key issues during this stage include land policy, subsidies, border tariffs, and trade issues.

There are several important elements to current Japan-U.S. rice issues. First of all, the United States is a major exporter of rice. The United States desires an opportunity to sell some of its rice to Japan to help balance the current trade deficit with Japan. In Japan, there is a desire to remain self-sufficient with regard to rice production. In addition, the importing of foreign rice will inevitably increase competition and result in lower rice prices in Japan. Japanese farmers are opposed to lower prices, as the cost of land is very high. Other issues include discussion of rice quality and the cultural significance of rice.

As in Stage II, in Stage III there is also a shift in the quality of food that people demand.

handout #2

STAGES OF AGRICULTURAL DEVELOPMENT ORGANIZER

	Stage I	Stage II	Stage III
Income Per Capita			
Example Countries			
Policy Goals			
Major Domestic Issues			
Primary Food Source			
Major International Issues			

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VOCABULARY

capital:	money used to finance purchase of the means of production, such as machines, or the machines themselves.
crop regulatory policy:	a policy that regulates the crops and amounts of a crop that farmers can plant. An example of this would be a shift from rice production to tobacco or sugarcane production.
export:	any good or service sold from one nation to another.
fertilizer subsidy policy:	a policy that helps reduce the cost of fertilizer, thereby lowering production costs and encouraging increased production. Promotes use of new fertilizer and other agricultural chemical technology.
green revolution:	term used to describe the successful trends in rice production over the past 30 years. Self-sufficiency rates increased, rice production grew faster than in previous years, land use improved, and new technology was utilized.
high-yield variety (HYV):	new varieties of rice created and first released in 1967 by researchers in the Philippines and Indonesia. Allowed for a near doubling of average rice yields between 1968 and 1989.
import:	a commodity purchased from another country.
income distribution:	division of society's output (income earned) among people. Income distribution concerns the matter of who gets how much, or what proportion of, the economy's total production.
industrialization:	period in which social and economic organization is characterized by large industries, machine production, and urban workers.
infrastructure:	a country's basic economic and social capital needed as a base for modern production. Examples: roads, telephone lines, schools, power facilities.
investment:	the purchase of property with the expectation that its value will increase over time.

handout #3

market:	an arena in which demand and supply for a particular good are established.
per capita income:	a country's average personal income per person.
policy:	A principle, plan, etc., as of a government.
price support policy:	policy that uses a government supported price "floor" that is higher than the price that would exist in a free market. Consumers pay this higher price for the good, and thus the producers receive a higher price. A surplus of that good is the result of this price support. The government must purchase, store, and administer this excess amount. A price support in agriculture helps farmers receive a higher income and combat rising costs of production.
public investment policy:	policy used by government to develop new technology and improve current infrastructure. Examples of this include research and development (R & D) to develop new types of rice seed or fertilizer, and investment in roads and irrigation systems.
staple:	a chief commodity grown or made in a certain place. Often seen as the basic needs for a person, such as rice and wheat.
subsidy:	payment (usually by government) to businesses or households that enables them to produce or consume a product in larger quantities or at lower prices than they would otherwise.
subsistence:	the bare minimum level at which a person or family can survive. Subsistence levels of food and wages are common examples.
surplus:	the quantity supplied over and above that which is demanded at a given price; that quantity over and above that which is needed or used.
tariff:	a government tax on imports, designed either to raise revenue or to protect domestic industry from foreign competition.

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STAGES OF AGRICULTURAL DEVELOPMENT QUESTIONS

Answer the following questions based on Handout #1, Stages of Agricultural Development, and after you have completed Handout #2, Stages of Agricultural Development Organizer.

Stage I

1. If you had $400, what types of things would you buy?

2. Now, if you had only $100, which items on your list would you still be able to buy?

3. Keeping that in mind, imagine you are living in Bangladesh, and that $100 is all you have to feed your family of four for ONE YEAR. How would your list of things to buy change?

4. Some families in America spend an average of $100 per WEEK at the grocery store. What implications does this have for policy about food and agriculture in Bangladesh? In the United States?

5. How might a government help with the process of improving food production in Stage I countries?

6. What are some ways that the government can help to improve the country's infrastructure? (for example, better irrigation systems, better roads, increased education for the general public)

7. What are some examples of improved technology that might be useful to these Stage I countries? (for example, HYV of rice, new machines, transplanting, fertilizer)

handout #4

Stage II

1. What issues might arise with more people moving to cities and working in the industrial sector? Remember, the total population is increasing.

2. How do you think a person's diet might change given an increase in income?

3. What foods do we typically associate with higher income?

4. What is meant by the "meat effect" in this case?

Stage III

1. How might the growth of large cities affect the price of land? What about the price of labor?

2. What is a subsidy?

3. What does the data below suggest about the economic and agricultural development of each country?

Retail Price of Rice in Selected Countries (1990)

- Bangladesh—$440/ton
- Indonesia—$300/ton
- Japan—$3464/ton
- Thailand—$280/ton

- Why might the Japanese price be so high in the data above?

- Explain what you know about what is currently happening between Japan and the United States with regards to rice.

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- Do you see evidence for the "meat effect" in our lives in the United States today?

- How has the role of agriculture changed during each stage of development?

- Describe some ways policy impacts agriculture.

handout #5

Country Presentation Instructions

Your group has been chosen to represent your country at the upcoming International Rice Summit (IRS). You will be introducing your country to the other IRS countries as well as summarizing your country's main agricultural development issues. You will be using your expertise to both offer advice to other nations as well as to accept suggestions from other nations.

Therefore, your presentation should include a brief introduction about your country's population, per capita income, and natural resources. It should also include a summary of the major issues facing your country in regards to agricultural development.

To make a thorough presentation, use the information on Handout #1, Stages of Agricultural Development, and the specific statistics and issues about your country on your country information sheet.

Each IRS country may choose to make visual aids (posters, charts and graphs, props) for its presentation.

You will present your information during lesson 7.

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STAGES OF AGRICULTURAL DEVELOPMENT ORGANIZER: ANSWER KEY

	Stage I	Stage II	Stage III
Income Per Capita	$100–$500 per year	$500–$4000 per year	$4000–$25,000 per year
Example Countries	Bangladesh	Indonesia, Thailand, China, Philippines	Japan
Policy Goals	Increasing agricultural output	Industrialize but maintain balance between agriculture and industry	Protect agriculture
Major Domestic Issues	Technology, human capital, infrastructure, poverty	Food supplies, markets for industrialization, savings, investments, income distribution	Subsidies, border tariffs, land policy, special interests
Primary Food Source	Staples like grain, rice	Still based on staples, with the addition of more meat and vegetables	"Quality" foods including meat, fish, poultry, fresh vegetables, and processed foods.
Major International Issues	Aid from Stage III countries	Grain trade with other countries	Trade negotiations

Lesson 7

INTERNATIONAL RICE SUMMIT

Organizing Questions

- What measures can be taken in a society to decrease the number of hungry people and the severe effects of this hunger on their lives?
- What are some policies a society can use to decrease the number of hungry individuals and the severity with which their lives are affected?
- How can policymakers learn from the experiences of rice-growing countries to feed the hungry people of their country in the near and distant future?

Introduction

> Perhaps the most important aspect of the global perspective on the world food problem cannot readily be captured in price or trade statistics. The world's food economy is now intimately and probably inextricably interdependent.... Solutions are likely to be found not by attempts to dismantle this new interdependence but by a better understanding and utilization of its positive potential at the national level. (Peter Timmer, Walter Falcon, and Scott Pearson, "Introduction to Food Policy Analysis," in *Food Policy Analysis*, pp. 4-5.)

> A government program to deal specifically and effectively with hunger requires an understanding of (1) who the hungry are; (2) how food intake changes when people's circumstances change; (3) the program interventions that will raise food intake; and (4) how programs can be linked to policy. (Peter Timmer, Walter Falcon, and Scott Pearson, "Analysis of Food Consumption and Nutrition," in *Food Policy Analysis*, p. 20.)

As we look into the future of the world's rice agriculture, we see several problems to contend with: the number of hungry people on Earth is rapidly rising, the environment is responding to this increased pressure, and our technological advances are not only bringing people closer together but also driving them economically farther apart. All these problems exist without regard for national borders. Although every country has specific problems to address as the year 2050 approaches, there are also commonalities between nations confronting similar population issues, environmental issues, technology issues, economic issues, or political issues. In this evolving global community, nations have become

increasingly interdependent. On the issue of world hunger, many experts feel it is in everyone's best interests to cooperate and share agricultural knowledge, experience, and technology to improve the quality of life for all human beings. In this activity, students will simulate a gathering of nations for an International Rice Summit (IRS) meeting, with the purpose of sharing knowledge and experience in trying to feed hungry people.

Objectives

knowledge

- to learn information about a population scenario in China
- to apply knowledge and experience developed in the previous six lessons of the unit

attitude

- to appreciate the complexity of problems and possible solutions a country faces as it tries to improve the quality of life of its citizens through agricultural development

skill

- to give effective and persuasive oral presentations, including the use of visuals
- to prioritize and rank issues in the order of their appropriateness to a given situation, weighing pros and cons
- to write a persuasive essay, asserting a position and supporting that position with evidence learned in the lesson
- to compromise within a small group

Materials

- Handout #1: Scenario for China in the Year 2050, one per group
- Handout #2: Key Questions, one per student
- Key Questions, Discussion/Possible Answers, for the teacher
- Rice Agricultural Development Policy Cards (one set per group, 14 cards per set)
- Agricultural Development Policy Recommendation Chart, overhead transparency
- pens or pencils
- binder paper

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Procedure

1. Before the International Rice Summit (IRS) simulation begins, students should re-examine their rice plants from lesson 1. Ask students to gather in their original country groups from lesson 1 and lesson 6. Set the stage for the students by explaining, "The year is 2050. The rice crops have sprouted and it is time to 'harvest.' Now it is time to assess the outcome of your decisions at the beginning of the unit." Groups will be giving a status report on the productivity of their farming and suggest improvements. Ask students to answer the following questions about their rice experiments in order to present their answers during the Summit introductions:
   - How many plants actually sprouted and are still growing?
   - Assuming that each plant represents enough rice to feed 10 million people, compare the number of plants growing with the number of people in your population now (remember that the year is 2050). Are you meeting the food needs of your population?
   - Look around at the plants of other countries. Why did some countries meet their needs and not others?
   - Why do you think the "self-sufficient" countries (those who grew enough food for their population) were successful? For example, did they plant more than they needed? Did they have better soil, water, light, or other conditions?
   - What are some alternatives for the countries that did not grow enough rice? And for the countries who grew too much rice? (Discuss trade between nations.)
   - What would you have done differently if you knew at the beginning of the unit what you know now?
2. Begin the IRS simulation by welcoming the delegates from the six countries, explaining that the first order of business is to for each country's delegates to introduce the current situation of their nation. In their country groups, students will present their answers to the questions about the rice seeds they planted during lesson 1. They will also give the presentations they prepared in lesson 6 to introduce their country and the agricultural development issues that are most affecting them currently. This provides a context for the rest of the "assembly" for the duration of the Summit.
3. Tell students that the representatives from China have come to the IRS to ask for technological advice and policy recommendations for developing their agricultural sector wisely and sustainably.
4. Distribute Handout #1, Scenario for China in the Year 2050, to each group and give students approximately 10-15 minutes to read about and discuss China's situation and compare it to their

own, keeping in mind that their country will mostly likely be directly or indirectly affected by China's agricultural policy decisions in the future. Suggest they consider the following questions:

- What stage of agricultural development is China in?
- How do the climate and ecosystems of China affect its rice production?
- What role does rice agriculture play in the nation's economy?
- Considering China's goals and constraints to improving rice production, what information and technology do the IRS countries have that would aid China?

5. Explain to the students that their task as representatives to IRS is to advise China's policymakers on how best to proceed in this critical period of their agricultural development. Give each country group a set of Rice Agricultural Development Policy Cards and a copy of Handout #2, Key Questions.

   On the front of each Policy Card is written a possible policy suggested by IRS researchers. On the back of the card is printed one advantage and one disadvantage that a country may encounter when it implements the policy. Policies range in focus from technological inputs, to environmental considerations, to population issues, to resource and distribution issues, and to political and economic issues. Explain to students that the Key Questions have been generated by IRS analysts as the most important questions facing rice-growing countries for the future.

   At the end of the activity, students will have to write a final summary of how their policy recommendations for China address one of these Key Questions. An answer key/discussion aid for the Key Questions is included to help the teacher aid students in their discussions, though there are no "right answers."

6. All of the policies are important; to use all of them would be ideal. But because this unit is meant to simulate real life, implementing all the policies is not possible. Each IRS country group must therefore sort and prioritize the cards, from the policies they would most recommend implementing for China's situation, to the policies they would least like to implement in China. They must finally choose their top five recommendations as the most important policies China should address.

7. In order to prioritize their cards carefully, each group must generate a list of at least one more advantage and at least one

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more disadvantage for each card before or during their sorting, based on the Key Questions, what students know about China, and what they know about the issues from the previous six lessons of the unit.

You may have students write directly on their cards, allowing them to manipulate and sort their cards more easily. Or you may wish to have students makes their lists on separate pieces of paper so that you can reuse the cards for other classes. As students sort the Policy Cards, emphasize the fact that no issue involving the environment or development ever has one correct answer. There is no panacea. Every solution has some drawback or flaw that must be weighed in a cost-benefit analysis when recommending policies for development.

8. Once each group has chosen their top five recommendations, ask a representative from the group to present them to the Summit assembly (the whole class) as "priority votes" for those policies. They must explain their reasoning and the advantages and disadvantages for each policy to the rest of the class. You may wish to allow optional visual aids (charts, graphs, overhead transparencies).

Enter each country's five choices onto the overhead of the Agricultural Development Policy Recommendation Chart. When all of the countries have finished their presentations, count the number of priority votes each policy received. The three policies that four or more of the six countries recommended will be the "official recommendation" for China (if there are none that four countries voted for, take the three policies with the most votes). Write the three policies receiving the most priority votes on the overhead.

9. As a culminating assignment, ask students to choose one Key Question that they consider to be the most important for the future of rice agriculture in the world. Each student must now write a letter to IRS summarizing his or her own opinion of which three policies sufficiently address the needs of China and the Key Question they chose. They may use the three policies voted on by the class, or may choose three other policies they consider to be better. You can use this as a final assessment tool, as the final piece of a portfolio packet for the *Feeding a Hungry World* unit, or as an optional writing assignment.

10. To debrief the IRS simulation, discuss the following questions with the students:

    - How was this different from the simulation in lesson 1? Did it make a difference that you were working to solve someone else's problem?

- Did competition arise in this activity as it did in lesson 1? Why do you think it did or didn't?
- How did your group choose the top five recommendations?
- How do you think this simulation compares to what is happening or what will happen in the "real world?"

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SCENARIO FOR CHINA IN THE YEAR 2050

The year is 2050. China's population has grown from 1995 levels of 1.2 billion to present levels of over 1.6 billion. Due in part to enforcement of one child per family laws, population levels stabilized in 2040. There have been slight annual population declines since that year.

Much of the land devoted to rice production, particularly in the fertile southern provinces, has been claimed for other uses. Between 1990 and 2010, an average of 10,000 new miles of roads were constructed in China. The number of cars in use during this period increased from fewer than 2 million to over 20 million.

In addition to the conversion of land for roads, many new factories and housing developments were built on former rice lands during that period. In 2010, the Chinese government passed strong land use laws, and the rate of cropland conversion to other uses declined. Many cities have passed greenbelt laws, restricting further expansion of cities and factories. Most of the remaining agricultural lands cannot be converted for other uses, without passing a stringent review process. Recognizing that the lack of agricultural land was a major problem, the government has been promoting the reconversion of some lands back to agricultural uses since 2030.

Per capita grain production in China reached its highest levels in the year 2005 at 350 kilograms per person. This was due in part to the use of higher-yield varieties of rice, and the increased use of fertilizers and pesticides. By 2050, however, per capita domestic production of rice had declined to 270 kilograms. Although China has imported grain since 1995, the seriousness of the shortfall has become increasingly severe since 2030. Since that year, China has imported over 100 million tons of rice per year. Much of the rice has come from North America.

There is now a great deal of regional variation in per capita income. While the coastal areas, primarily Shanghai and Guangzhou, continued to experience economic development through the early part of the 21st century, some areas of the country did not share in this rapid development.

In 2050, the demand for rice in China is greater than the surplus of traditional suppliers to China. Imports from countries such as the United States are insufficient. Provinces in the interior are particularly hard hit by the lack of grain, and there have been several major protests against government food policies. The central government has decided to increase its import of rice, and has promised to subsidize distribution of grain in the poorer regions.

Representatives of the Chinese government have convened at the International Rice Summit to discuss ways of meeting current shortfalls. Also present at the meeting are delegations from Japan, Indonesia, the Philippines, Thailand, and Bangladesh.

handout #2

KEY QUESTIONS

1. Considering the increasing population and the corresponding increasing pressures on agricultural systems globally:
   - What do you think will happen to the prices of rice in the future?

   - How do you think this will affect people's diets and the amount of rice they consume around the world?

   - How can agricultural and economic policies play a role in affecting the amount of rice people consume?

2. Regarding natural resource use and rice:
   - How does the amount and pattern of rice consumption affect the way we use natural resources in our agriculture? How will it affect the environment?

   - In the reverse, how will changes in the way we use resources in agriculture affect rice agriculture and rice prices?

3. Based on the rapid population growth in Asia and the Pacific and the progress of these countries toward the third stage of agricultural development (more consumption of resources per person):
   - What will happen to the cities versus the farms?

   - What will be the impact of this "urbanization" on rice prices and rice production around the world?

4. How will the following groups in society be affected by changes in agricultural policy?

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- the upper class (rich)
- the lower class (poor)

5. What role will biotechnology (genetic engineering) play in the future of rice agriculture?

6. As nations strive to move through levels of economic development, oftentimes long-term sustainability is sacrificed to meet people's needs quickly and cheaply. How can developed countries such as the United States and Japan aid developing nations in sustainable development without encroaching on the sovereignty of each nation?

KEY QUESTIONS: DISCUSSION/POSSIBLE ANSWERS

1. Considering the increasing population and the corresponding increasing pressures on agricultural systems globally:
   - What do you think will happen to the prices of rice in the future? *As supplies of grain diminish relative to demand, prices are likely to increase. Food prices are often a cause for social unrest.*
   - How do you think this will affect people's diets and the amount of rice they consume around the world? *The diet of the poor, in particular, may suffer from the shortage of rice.*
   - How can agricultural and economic policies play a role in affecting the amount of rice people consume? *Through research and planning, policies may prevent or delay declines in production.*
2. Regarding natural resource use and rice:
   - How does the amount and pattern of rice consumption discussed above affect the way we use natural resources in our agriculture? How will it affect the environment? *As our consumption of rice increases with the population, and since the increase in population will be in the poorer sections of society whose diet consists of more rice than the richer people, we will search for higher and higher yields in rice agriculture, potentially stripping our natural resources and damaging the environment. The alternative is that we will impose sustainable farming methods initially at the expense of the population, but hopefully our technology will allow us to sustain our resources and have high yields.*
   - In the reverse, how will changes in the way we use resources in agriculture affect rice agriculture and rice prices? *As mentioned above, we can have two basic policies concerning natural resource use in rice agriculture: (1) promote input-intensive farming methods to increase yields, with fertilizers, pesticides, and machines—this would probably drive rice prices down because these technologies are costly but produce high yields; (2) or promote labor-intensive farming methods to ensure sustainability of resources—this would probably drive rice prices up, at least in the short term, because labor is more costly and yields are not as high.*
3. Based on the rapid population growth in Asia and the Pacific and the progress of these countries toward the third stage of agricultural development (more consumption of resources per person):
   - What will happen to the cities versus the farms? *Cities are likely to continue to grow and there will be fewer people in agriculture and fewer farms.*

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- What will be the impact of this "urbanization" on rice prices and rice production around the world? *As cities grow larger and more people move away from the countryside and the farms, rice agriculture could be hit hard by the lack of labor. This could drive production down and prices up.*

4. How will the following groups in society be affected by changes in agricultural policy?
   - the upper class (rich)
   - the lower class (poor)

   The impact is not likely to be felt by the rich since they will be able to purchase most of their food needs. The poor are the most affected by food shortages.

5. What role will biotechnology (genetic engineering) play in the future of rice agriculture? *With the research and production of high yield varieties such as Super Rice, genetically engineered rice varieties will become more available around the world, allowing farmers to use rice species specially adapted/engineered for the climate, transport, and storage conditions in their area. This will also raise issues of bioethics and whether it is more beneficial to use wild rice varieties and hybridization that doesn't involve genetic engineering.*

6. As nations strive to move through levels of economic development, oftentimes long-term sustainability is sacrificed to meet people's needs quickly and cheaply. How can developed countries such as the United States and Japan aid these nations in sustainable development without encroaching on the sovereignty of each nation? *It is likely that these countries can provide some expertise in areas of sustainable development, environmental protection, and agricultural research. The degree to which countries are likely to accept such help depends on several factors, such as nationalism, and perceptions of fairness in the terms of international trade.*

RICE AGRICULTURAL DEVELOPMENT POLICY CARDS

Policy #1

Plant only the Super Rice variety of rice (genetically engineered to be resistant to many pests and diseases) across the whole of China's rice farm areas.

Policy #2

Use a polycropping system of farming to raise rice, fish, and fruit trees together in the same farm, so that farmers can feed their families with more than one crop, and sell the extra at a local market.

Policy #3

Implement a polycropping system of farming to raise rice and cash crops (crops grown exclusively for sale), with the potential for exporting the cash crops to other nations.

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Policy #1

advantages:

- Super Rice has a high yield, and farms will be able to feed more people using less farmland.

disadvantages:

- Super Rice requires expensive agricultural inputs, such as fertilizers, pesticides, and herbicides.

Policy #2

advantages:

- Farms would be self-sufficient in terms of providing food for the family and workers.

disadvantages:

- Polycropping is very labor-intensive, and labor is expensive.

Policy #3

advantages:

- Farms would contribute to improving the nation's economy by exporting cash crops.

disadvantages:

- Polycropping is very labor-intensive, and labor is expensive.

Policy #4

Impose a heavy tax on any family with more than one child in order to encourage citizens to have small families.

Policy #5

Educate and encourage the use of birth control methods for all citizens.

Policy #6

Reinforce education and public health programs for women. These have been proven to have a reduction effect on birth rates and population growth.

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Policy #4

advantages:

- Charging a tax will increase the government's income, allowing the possibility of government funding for other population-reduction programs.

disadvantages:

- The poorer sectors of society are usually the ones that have very large families, therefore they would be the ones most penalized by a "tax on children."

Policy #5

advantages:

- This policy gives the responsibility and freedom to choose the size of the family to the citizens.

disadvantages:

- Using birth control methods may be against many people's belief systems and so they won't use them.

Policy #6

advantages:

- Educated women have been shown to have fewer children, thereby decreasing the population and demand on resources and increasing the standard of living.

disadvantages:

- In some countries for cultural reasons, traditionally people are not used to the idea of educating women, which is very costly, and feel that this money could be better spent elsewhere.

Policy #7

Increase the use of agricultural technology, such as machinery and chemical pesticides and fertilizers, thus allowing fewer people to work on the farms and instead move to the cities to more industrial jobs.

Policy #8

Modify traditional methods of farming, using minimal technology and increasing labor done by hand, to improve rice production.

Policy #9

Increase the amount of land under agricultural production by turning open-space areas and underutilized industrial areas into farmland.

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Policy #7

advantages:

- These technologies often save time and labor costs because they increase yields by carrying out tasks that cannot be done the same way by hand.

disadvantages:

- Intensifying technological inputs in rice agriculture often causes much more environmental degradation in the form of water and air pollution.

Policy #8

advantages:

- Traditional farming methods often have much less damaging impact on the environment.

disadvantages:

- The yields for farms that depend on labor are often much less than those that use more technology.

Policy #9

advantages:

- This policy would increase China's agricultural output and possibly improve the GNP.

disadvantages:

- This would probably require the destruction of rain forests and wetlands, both very fragile and important ecosystems.

Policy #10

Subsidize rice agriculture by paying rice farmers extra money to plant rice on their land.

Policy #11

Increase manufactured exports to the United States to provide for the foreign exchange import of grain.

Policy #12

Focus spending on improving the infrastructure of China, such as building new and better roads and other means of transporting rice and other agricultural products.

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Policy #10

advantages:

- This would increase the annual per capita income for almost half the employed people in China, particularly in poorer regions, because almost half of employment in those regions is in rice agriculture.

disadvantages:

- This would require a substantial investment by the central government.

Policy #11

advantages:

- This would enable China to spend money on building infrastructure and obtaining new technology for its agriculture.

disadvantages:

- This increases China's dependence on foreign trade instead of trying to increase economic independence.

Policy #12

advantages:

- Oftentimes, a country's food poverty is not due to low production but to poor transportation and distribution of goods. This policy would help alleviate these problems.

disadvantages:

- More land would be lost to roads, taking away already scarce agricultural lands.

Policy #13

Target food subsidy programs to the rural poor and let the near poor and urban poor fend for themselves.

Policy #14

Educate and implement an integrated pest management system of pest control in the rice fields, using natural predators like insects to control pests, instead of chemicals.

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Policy #13

advantages:

- Scarce food resources could be allocated to those with the best chances of survival.

disadvantages:

- Severe malnutrition and possible starvation would face some of the people living in the poorest regions.

Policy #14

advantages:

- This method of pest control does not harm the environment like chemical pesticides do.

disadvantages:

- This method is slightly less effective and takes longer to implement than the chemical pesticide system.

transparency

Agricultural Development Policy Recommendation Chart

	Indonesia	China	Bangladesh	Japan	Thailand	Philippines
1st Priority	Policy #	Policy #	Policy #	Policy #	Policy #	Policy #
2nd Priority	Policy #	Policy #	Policy #	Policy #	Policy #	Policy #
3rd Priority	Policy #	Policy #	Policy #	Policy #	Policy #	Policy #
4th Priority	Policy #	Policy #	Policy #	Policy #	Policy #	Policy #
5th Priority	Policy #	Policy #	Policy #	Policy #	Policy #	Policy #

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APPENDICES

STANFORD UNIVERSITY
INSTITUTE FOR INTERNATIONAL STUDIES
STANFORD, CALIFORNIA

Dear Students,

Rice is the world's most important food crop, and more than 90 percent of the world's rice is grown and consumed in Asia. Each year, approximately 80 million people are added to the world's population. Landless families are leaving the countryside for already overcrowded cities. In Asia, almost no more land is left to be converted for rice agriculture.

In thirty years, the population of the planet is expected to reach eight billion, of which more than half will be rice consumers. Feeding this large population will require a 60 percent increase in global rice production. The food crisis that threatened much of Asia in the 1960s and 1970s was averted by the discovery and diffusion of new rice growing technologies. To meet the food needs of the next century, we need to consider increasingly complex questions, such as maintaining biodiversity and improving environmental protection, while at the same time maintaining sustainability of yields and promoting equitable distribution, both of which are essential for eradicating world hunger.

The choices faced by governments and food policy analysts are not simple. While maintaining our continuing commitment to basic scientific research in the realm of improving rice growing technologies, we must also consider a number of other factors. Now more than ever, it is essential to understand the great variety of human cultures, and the impacts that international economic and political relations have on the world's people.

We have dedicated our careers to helping to meet the food needs of present and future generations. Within the next few years, many of you will be beginning your adult lives, and some of you may even choose to work in fields related to food research and policy. It is our hope that the efforts to meet the basic needs of the world's human population continue into the twenty-first century. You have an important role to play in the world's future.

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GLOSSARY

Also refer to the glossary at the end of lesson 4 for terms specific to rice agriculture, and the glossary at the end of lesson 6 for terms related to the stages of agricultural development.

agroclimatic zone:	general geographic zones with loosely shared climatic characteristics indicating which agricultural crops grow in that region.
anthropogenic:	created by humans
biodiversity or biological diversity:	the biological "wealth" of a system; the variety and complexity of life interacting in a system.
commercial agriculture:	farming in which the products are primarily grown and sold in a commercial market.
consumption:	the utilization of economic goods in the satisfaction of wants or in the process of production resulting chiefly in their destruction, deterioration, or transformation.
crop yield growth:	increasing the amount of a crop that is produced when the amount of land planted remains the same.
deforestation:	permanent replacement of a forest, often by clearing away all the trees in an area, by a non-forest system that cannot naturally revert to the original ecosystem. Deforestation is often the result of cutting logs for timber or clearing land for farms or for cattle grazing.
ecosystem:	the entire interlocking system of living beings in a biological and physical community.
environmental degradation:	destruction of a natural system, often due to human activity. This is a broad term and can refer to many different kinds of destruction, such as deforestation, desertification, soil erosion, etc.
fertilizer:	nutrients in the form of organic material or inorganic chemicals that farmers add to the soil to help plants grow better. Animal manure is an example of an organic fertilizer; chemical fertilizers are often compounds of nitrogen and other chemicals.
genetics:	a branch of biology that deals with the heredity and variation of organisms.
global warming:	a scientific theory that states that a buildup in the atmosphere of gases such as carbon dioxide, chlorofluorocarbons, and nitrous oxide is causing the earth to heat up. There is no consensus on the implications of the warming, but some scientists predict rising sea levels, tropical storms, shifts in climate and water supplies, pest proliferation, and many changes for agriculture.

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greenhouse effect: the effect produced by a growing accumulation of atmospheric gases that acts like a glass roof on our atmosphere and traps heat, much like a garden greenhouse. This effect occurs normally and enables life to exist on earth, but when too many gases are added, it can cause global warming.

herbicide: chemical used to destroy plants, usually weeds, that threaten to take over land set aside for crop plants or to decrease crop productivity.

impermeable soils: soils that do not allow water to spread easily through them. Such soils are particularly good for rice plants because rice grows best in standing water not easily absorbed by the soil.

integrated pest management: the use of one or more pest control tactics (for example, using natural predators like insects) instead of relying on just one tactic such as pesticides.

interdependence: when systems, events, or entities depend mutually on one another for survival. For example, countries are *interdependent* in their exchange of goods, services, and money.

kwashiorkor: a disease common in children in developing countries in that the lack of protein in the diet leaves children so malnourished that their bodies cannot fight off simple infections. Although the disease can be prevented with proper protein in the diet, if left untreated it often leads to death.

Malthus Hypothesis: theory developed by Thomas Malthus in the 1800s that predicted that the growth in human population would eventually outstrip our ability to produce enough food for everyone, leading to massive famine.

millet: a kind of grain related to rice that is grown for food, but often considered less desirable than rice.

monocropping: the farming of a single crop in an agroecosystem over time.

monsoon: from the Arabic word, *mansin*, meaning seasonal wind. A monsoon climate is dominated by seasonal winds that bring heavy rains during half the year and reverse direction during the other half of the year. In parts of South and Southeast Asia, the monsoon season is commonly referred to as the wet season because the rest of the year is relatively dry.

natural resource: any of the natural materials we use that come from the earth, such as water, soil, forests, coal, gas, and minerals.

organic: referring to or derived from living organisms. In contrast, inorganic substances typically refer to chemicals that have been created by humans out of materials that were nonliving.

glossary

Oryza sativa:	the scientific name for commonly cultivated rice. This species, one of the two important rice species for human nutrition, is grown worldwide. *Oryza glaberrima* is the other and is grown in parts of West Africa.
panicle:	clusters of rice grains that grow at the top of the ripe rice plant.
pesticide:	chemicals applied to crops to kill pests that would otherwise destroy parts of the crop. These may be insecticides, which are designed to kill insects, herbicides, which kill weeds (or "herbs"), or fungicides, which kill fungi. Because they are chemicals designed to kill, they are often dangerous to other forms of life, including wildlife and humans.
polycropping:	farming more than one crop, either on a given plot of land (intercropping) or within an agroecosystem.
rai:	Thai unit of land area.
self-sufficiency:	in terms of rice production, this refers to the ability of a given country to produce all the rice its people need without having to buy any from other countries.
soil erosion:	the wearing away of the surface of land due to wind or water, which decreases the ability of the soil to provide nutrients for growing plants. Although erosion occurs naturally as a result of weather or other sources, human activities can increase it.
species:	a scientific classification of life on earth based on similarities between organisms. It can be used either in the strict sense, as in the *species* name for human beings is *sapiens*, or more loosely to refer to animal and plant life (for example, the many *species* of life in a forest).
staple crop:	primary crop grown or produced in a region. For much of Asia and the Pacific, rice is the staple crop.
subsistence agriculture:	labor-intensive farming to raise food eaten primarily by farmers and their families; this is in contrast to commercial agriculture, which uses large machinery and is aimed at production for sale on the market.
subtropical:	a geographical region of the world close to the tropics, or the area bounded by the Tropics of Cancer and Capricorn.
sustainability:	used to describe the ability of a certain practice or system to meet the needs of the present generation as well as the next generation.
sustainable development:	meeting the needs of the present generation while making sure the next generation can meet its needs. This can mean providing transportation and electricity to poorer countries while trying to minimize the environmental destruction caused by these aspects of development.

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unequal distribution:	exists both within and between countries and refers to the situation of some people having more of something (money, food, resources, education, technology, etc.) than others. Some experts argue that this is the true cause of hunger, not lack of food.
yield growth:	see crop yield growth.

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